UNIVERSITY OF ALBERTA

TRANSIT NETWORK ANALYSIS BY REITERATION OF MODE SPLIT RELATIONSHIPS

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled TRANSIT NETWORK ANALYSIS BY REITERATION OF MODE SPLIT RELATIONSHIPS submitted by CHARLES ROBERT GORDON HALLS in partial fulfilment of the requirements for the degree of Master of Science.

ABSTRACT

The purpose of this study was to develop a technique of predicting the operational characteristics of possible transit system alternatives that would be required to attain various levels of mode split. The investigation used the 1964 Edmonton Transit System as the basic network and the mode split relationships for the City of Edmonton as determined by Rhyason, 1967.

The basic network was coded in a form suitable for minimum time trip path assignment according to data obtained from the City of Edmonton Transit System. Considerable time, beyond the requirements of this particular analysis, was spent in coding the network so that future testing of transit alternatives could be easily accomplished.

The minimum time "tree" and minimum "path" programs more commonly used for automobile networks were modified for use with a transit network by Dr. J. N. Supersad, and extensively tested on the network of this problem. These programs were used to find the minimum time path for transit trips between all Edmonton traffic origin zones, and three destination zones within the central area of the city. Only work trips in the morning peak hour were considered.

The trip paths thus determined were then reiterated using the mode split relationships determined by Rhyason, 1967. Each transit link was considered for each O-D pair, for each level of mode split which was tested. The test was run in 10% increments of mode split from 20% to 60%, chosen to extend on each side of the observed average mode split.

There was some concern that the mode split relationships determined by hand trip time assignment might not be valid when used in conjunction with mechanically determined trip paths. A program to find the mode split relationships by Rhyason's method was developed. No significant difference was found between mode split relationships using hand assigned trip paths and mechanically determined minimum time paths, but a difference was noted between the mode split relationships determined by hand curve fitting and mechanical regression analysis of the same data.

When all programs were tested, using the basic 1964 transit network, a test of a possible rapid transit system proposed by Bakker, 1968, was superimposed on the basic network and tested by the technique of this thesis. It was found that the average operating speed of the link of this system was sufficient to be able to attract higher than the present percentage of trips to transit. Since the analysis included only work trips to downtown destinations, it was impossible to compare the ridership assigned to the facility, to that required to support its operation. This capability does exist in the program and could be used if all trips were considered.

The study was successful in setting up a basic network and data file for future analysis problems using Edmonton data, and has documented the following programs which may be applicable to analysis problems in any city: "Tree" building and minimum path programs; "Required Speed" program; A "Mode Split" analysis program including subroutines to plot mode split - travel time ratio data, and calculate the relationship by regression analysis.

ACKNOWLEDGEMENTS

The Author wishes to express his appreciation to Associate Professor J. J. Bakker of the Department of Civil Engineering at the University of Alberta, Edmonton, for his guidance throughout this study.

Dr. J. N. Supersad, Past Doctoral Fellow of the Civil Engineering Department, University of Alberta, 1968, provided the Minimum Path Tree program used in this study, and gave freely of his time to assist in this and other programming problems. For this, and Dr. Supersad's example of a highly Professional and meticulous approach to this type of a problem, the Author is extremely grateful.

Appreciation is extended to Mr. A. R. Ross of the Edmonton Transit System for making available the data from which the basic transit network was developed.

The Author also wishes to acknowledge the financial assistance of the National Research Council toward this study, and his employers, the Alberta Department of Highways, who granted an Educational Leave for the duration of his enrolment in the Faculty of Graduate Studies.

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CHAPTER I

INTRODUCTION

The relative trips by transit compared to automobile, called the Mode Split, provides essential information concerning the overall transportation requirements of a city. This information relies on the premise that urban travel is orderly, habitual, and related to a set of causative factors which can be forecast. Mode split models are developed from measurements of the components of the existing transportation systems, the socio-economic characteristics of the trip maker, and the land use at destination. The model is tested and calibrated to represent known trip patterns and can then be used to estimate future travel for various combinations of future land use and transportation system configuration.

This thesis is an investigation into the use of an established mode split model for the testing of transit alternatives. It was initially apparent that time would limit the actual testing and analysis of transit facilities. The policy followed throughout the investigation was to spend the time and effort necessary to develop the basic transit network, data files, and analysis programs in a manner which would facilitate their use for testing of alternatives, even if this testing were to be the subject of future work.

STATEMENT OF THE PROBLEM

In common with most planning predictions, mode-split and other transportation models predict that the new will behave as the old. Mode split predictions are used mainly for policy decisions concerning the balance between the provision of highway and transit facilities.

This investigation considered the further use of mode split in transportation analysis; in particular the use of mode-split-travel time relationships in assessing transit alternatives. The problem is to develop a technique of predicting the operational characteristics of a possible transit system that would be required to attain various levels of ridership.

The basic transit network, Origin-Destination data, and Mode Split relationships were obtained from the City of Edmonton, 1964. Since the transit networks tested included a past bus transit system with a suggested future rapid transit system superimposed, the analysis does not intend to draw conclusions concerning specific facets of the Edmonton Transit System operation. The analysis rather used Edmonton data in an attempt to develop an analysis technique that would be applicable in any city.

LIMITATIONS

This thesis is more of an academic exercise than a research exercise, in that it has contributed considerable to the author's education, but may provide little contribution to the fund of knowledge in this field. With the exception of the analysis of speeds required to obtain various mode splits, the other components of the analysis have been used, in one form or another, for several years.

The transit network, while it does contain provision for the insertion of new links for testing, is coded to downtown destinations only. This was done to save time. If the network were to be expanded to other directions, note that simply coding the time or speed in the opposite direction is not accurate, since one direction is with, and the other against, the peak hour flow.

The analysis programs are physically separate operations, to facilitate checking each step, and to fit available computer time. Some of the operations should have been streamlined and condensed for more efficient operation.

Time did not permit detailed checking of the assumption that the minimum trip paths can be established using the optimum speed characteristics of a new facility such as a rapid transit line,

and that the minimum path thus determined remains the same at speeds associated with various mode splits. This was not anticipated as a problem since it was felt that by testing higher than actual mode splits, one would find speeds higher than optimum required. It was thought that one could thus estimate the practical mode split attainable within the desirable operating range of facilities being tested. In test the rapid transit lines were found to require operating speeds less than the optimum.

CHAPTER II

REVIEW OF PREVIOUS WORK

This thesis is an extension of, and relies heavily upon, the work of Rhyason, 1967. His work investigated changes in travel pattern with time and transit service changes. He used 1961 and 1964 origin-destination data from the City of Edmonton Metropolitan Edmonton Transportation Study traffic zones, 1961 auto travel times from M.E.T.S., and 1961 and 1964 Transit times. He concluded:

1. "The radical changes in transit routes did not affect the modal split relationships even though they did result in an increased mode split by reducing travel time. Thus, the effect of transit changes can be measured using the modal split relationships."

2. "Economic status and relative travel time are the chief factors affecting the choice of mode in Edmonton."

3. "The modal split relationships in Edmonton are dependent on the area of employment within the Central Business District."

4. "Parking plays an important role in the mode split."

5. "House sale value, which is easily obtained in Edmonton can be used as a reliable measured economic status."

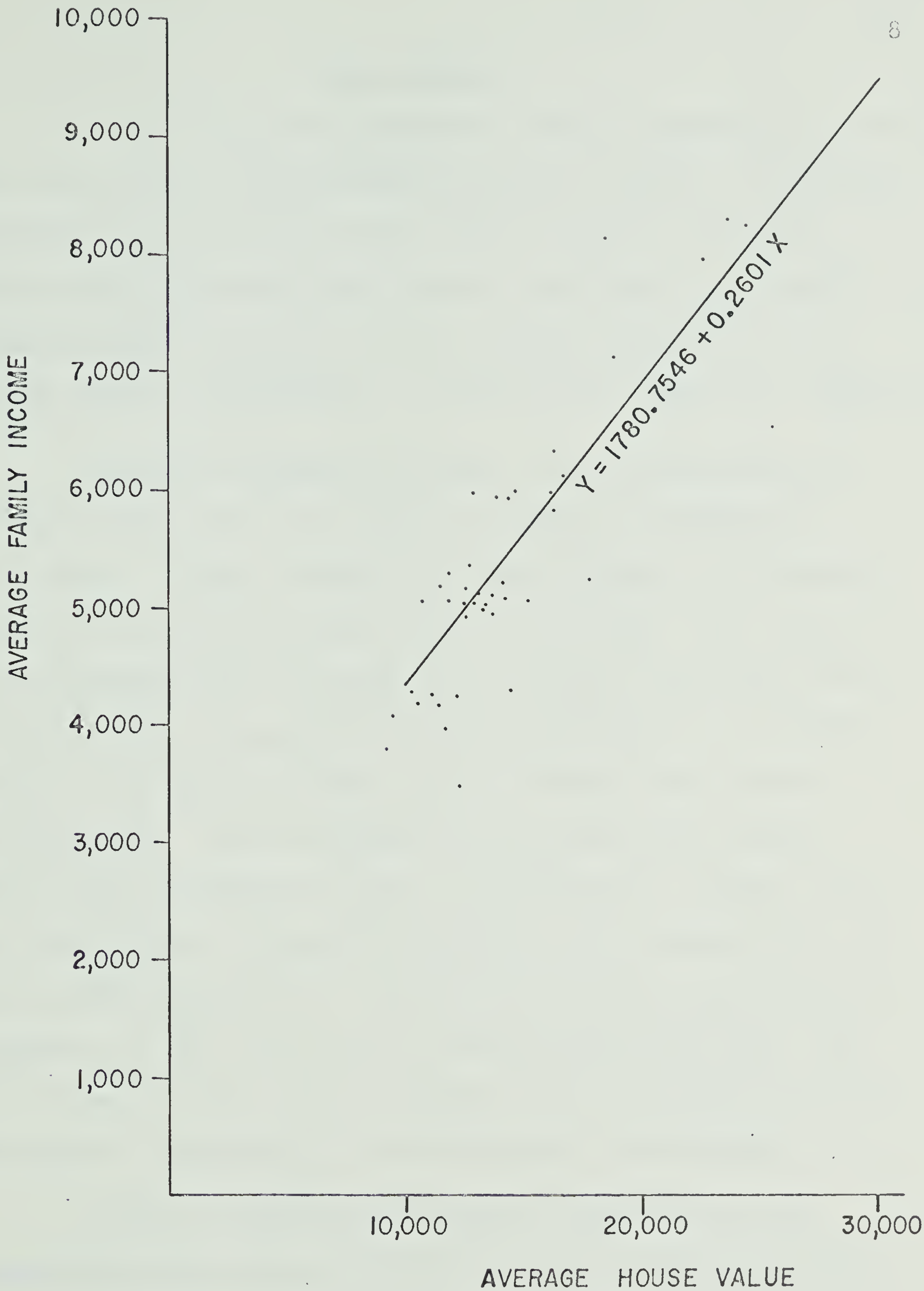
6. "Relative travel time can be measured with equal reliability by both travel time difference and travel time ratio in Edmonton."

To develop the 1964 mode split - travel time relationships, Rhyason used 1964 trips and transit data. He assumed that since there had been little change in the road system between 1961 and 1964, that 1961 auto travel data could be used. Since this assumption proved inaccurate, he was forced to develop a "bridge penalty" to be applied to auto trips, from south side origins to north side destinations. Further investigation of this procedure, suggested by Rhyason, has not been done, and 1961 auto travel data, with Rhyason's bridge penalty and auto terminal time assumptions were used in this thesis.

This thesis also uses Rhyason's mode split-travel time relationships stratified according to house sale value as the socio-economic indicator. Rhyason's recommendations to check the mode split thus established against the mode split as established by other, more common indicators such as car ownership or income have not been done.

Rhyason's Mode Split analysis used Average House Sale value as the socio-economic indicator. In the Metropolotan Edmonton Transportation Study, 1961, the number of cars per dwelling unit was used for this stratification, although no measure of standard error of estimate is given. The Calgary Transportation Study, 1967, (CALTS), used two socio-economic parameters: Mean family income and dwelling units per net residential acre. The Calgary Mode Split Model (CALTS Technical Report 4, 1968) had a standard error of estimate of 22% for transit work trips, and was able to predict actual work trips to the C.B.D. within 1.51 percent. Rhyason's Mode Split model had a standard error of estimate of 10 percent for A.M. peak hour transit trips to the Central Study Area (C.S.A.) and predicted actual trips within 2.17 percent. Table A.4 summarizes the actual and predicted trips to the C.S.A. in the A.M. peak hour, Edmonton, 1964. Considering the relative ease with which House Value Data can be collected as compared to the more sophisticated Calgary model, the prediction accuracy of Rhyason's model seems more than satisfactory.

Most mode split models use Average Family Income as the socio-economic indicator. The correlation of Average House Value to this more common parameter was checked. Figure 2.1 shows the relationship between Average Family Income and Average House Value for Edmonton Census districts. Average Family Income data was obtained from a publication by Dr. G. Kupfer, 1967, and used with Rhyason's 1961 house value data. The coefficient of correlation is 0.848, commensurate with the accuracy of prediction.



EDMONTON 1961

URE 2.1 CORRELATION OF AVERAGE HOUSE VALUE TO AVERAGE FAMILY INCOME

COEFFICIENT OF CORRELATION = 0·848

DATA AVAILABLE

This study uses Metropolitan Edmonton Transportation Study (M.E.T.S.) and other data previously collected by Rhyason. FIGURE 2.2 shows the original M.E.T.S. Traffic zones in the City of Edmonton. Rhyason found the Average House Value for each traffic zone from the weighted average of 1961 and 1964 sales records, maintained by the City of Edmonton Land Department. These data are summarized in TABLE A.1.

Rhyason's assignment of transit and auto trips resulted in total trip times which are summarized in APPENDIX A, TABLES A.2.1, A.2.2, A.2.3. A trip is composed of several definable time increments, generally subdivided into travel time and excess time. For a transit trip, the excess time is composed of time walking to the transit stop, time waiting for a bus, possibly includes time waiting for a transfer as part of the trip, and finally the walk from the transit stop to the destination. For an automobile trip the excess time includes time to park the vehicle and walk to the destination. Rhyason's trip path assignment was not handled mechanically. This allowed him to use trip patterns determined from observations of Edmonton Transit System inspectors, if they varied from the strictly minimum time path. Note that the excess travel time for automobile trips was assumed at a uniform four (4) minutes for all origin-destination combinations.

TABLE A.3 summarizes the observed number of work trips between each origin and the destination considered. This information was found by the Origin-Destination survey conducted by The City of Edmonton in 1964.

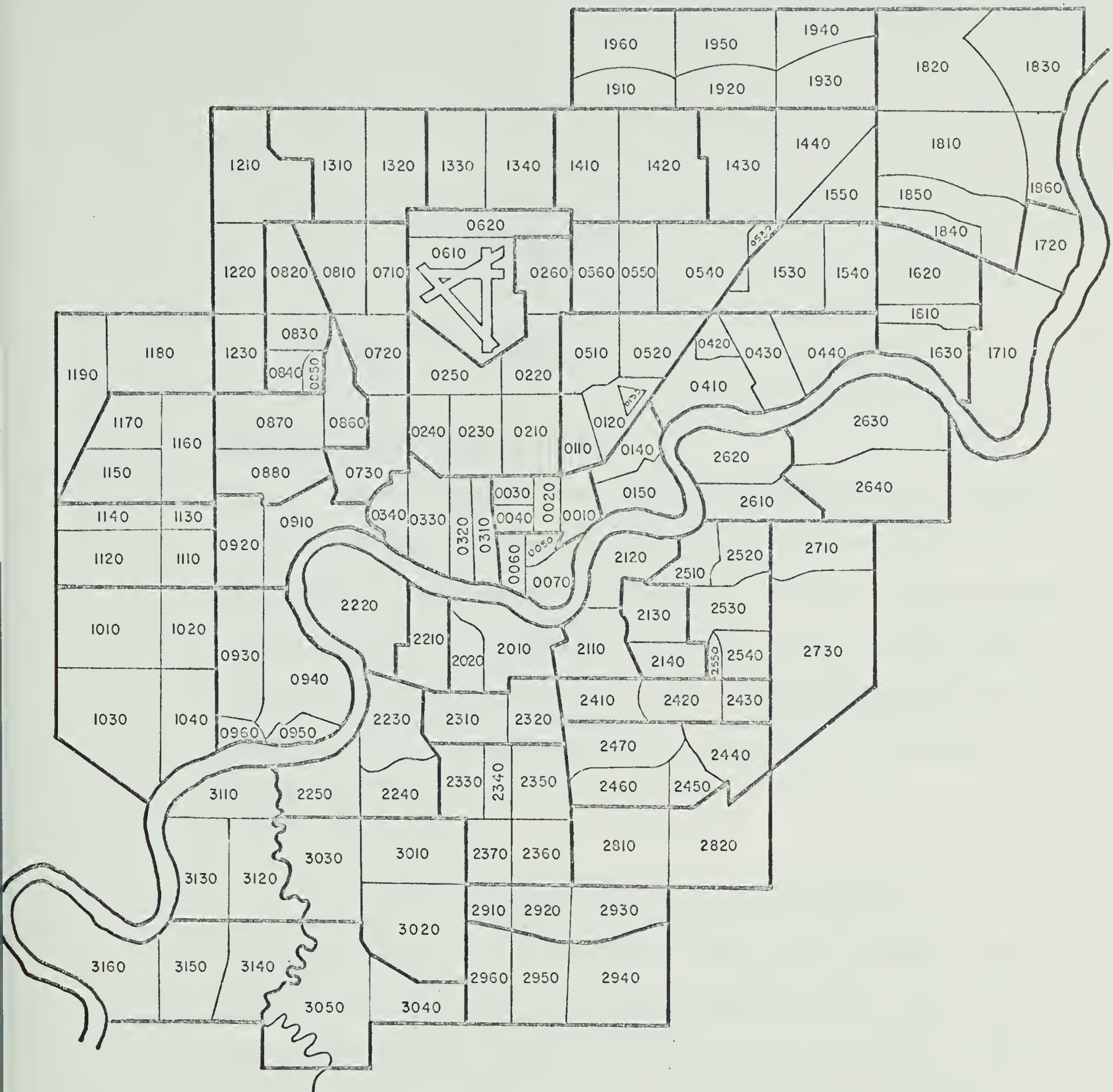


FIGURE 2.2 METROPOLITAN EDMONTON TRANSPORTATION STUDY TRAFFIC ZONES

CHAPTER III

THEORY

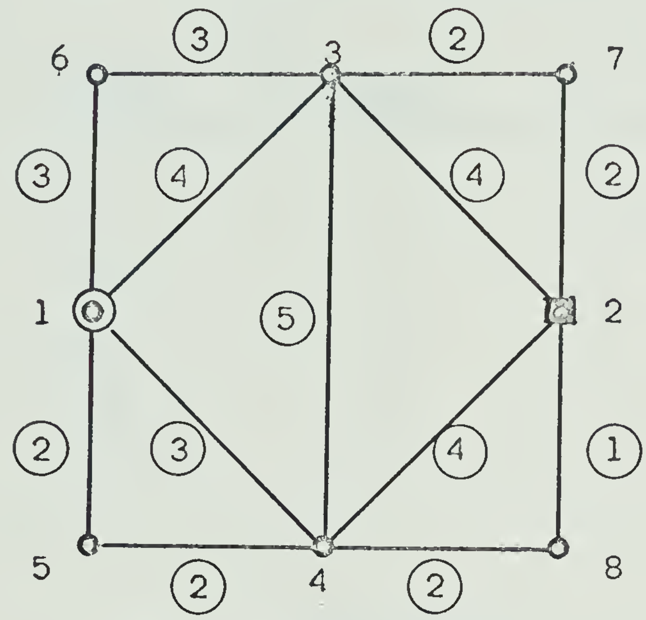
1. Minimum Path Trip Assignment

For transportation planning purposes, it is necessary to know the expected path of trips between any two points on the system. It is generally accepted that the best approximation of this path is the minimum time path, or some variation using distance and cost in addition to time. The Moore Algorithem is widely used for this purpose. (U. S. Department of Commerce, 1964)

The Moore Algorithem "builds" a minimum path "Tree" from each origin node to each other node in the network. FIGURE 3.1 shows a very simple transportation network. The following description of finding the minimum path from origin to destination is progressively illustrated graphically by FIGURES 3.2, 3.3, 3.4, 3.5, and serve to illustrate the principle of the Moore Algorithem.

FIGURE 3.1

SIMPLE TRANSPORTATION NETWORK



1 Origin Centroid

2 Destination Centroid

7 Node

2 Link Time

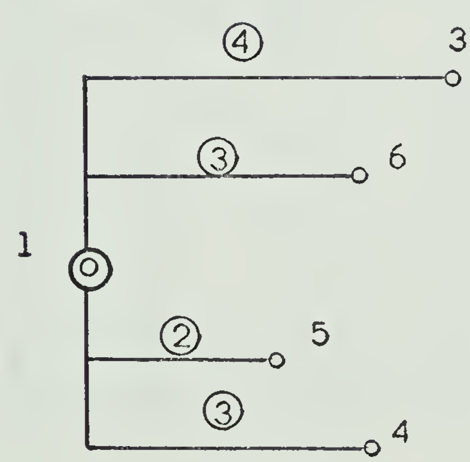
(All links are two way)

Note: The above convention is used throughout the example

1. Beginning at 1, record time on all links beginning at Centroid 1.

Link	Time	Cumulative Time
1-6	3	3
1-3	4	4
1-4	3	3
1-5	2	2

FIGURE 3.2



2. From each of the nodes now reached, record time on all links that can be reached.

Link	Time	Cum. Time
3-7	2	6
3-2	4	8 X
3-4	5	9 X
3-1	Reverse	
3-6	Reverse	

Link	Time	Cum. Time
6-1	Reverse	
6-3	3	6 X

Link	Time	Cum. Time
5-1	Reverse	
5-4	2	4 X

Link	Time	Cum. Time
4-1	Reverse	
4-5	Reverse	
4-3	5	8 X
4-8	2	5
4-2	4	7

Origin	Node	Min. Cumulative Travel Time
1	3	4
1	5	2
1	4	3
1	6	3

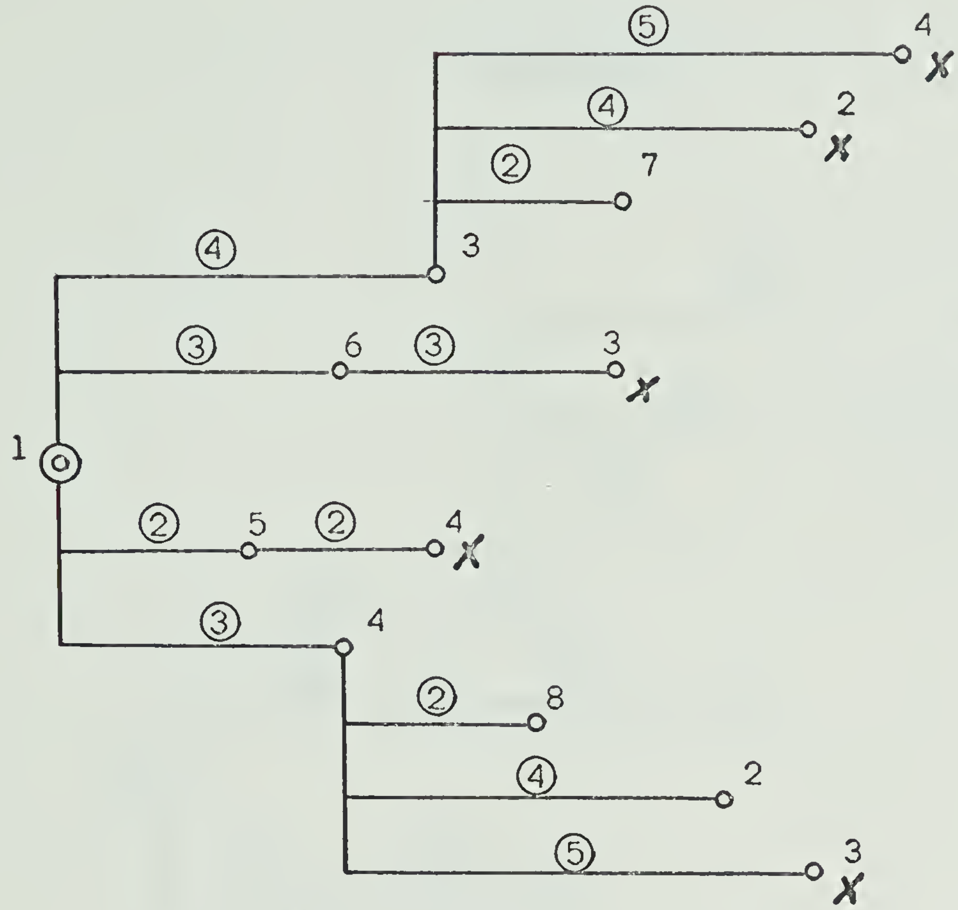
From those nodes left, record time on links that can be reached.

Link	Time	Cum. Time
2-3	Reverse	
2-7	2	9
2-8	1	8
2-4	Reverse	

Link	Time	Cum. Time
7-3	Reverse	
7-2	2	8

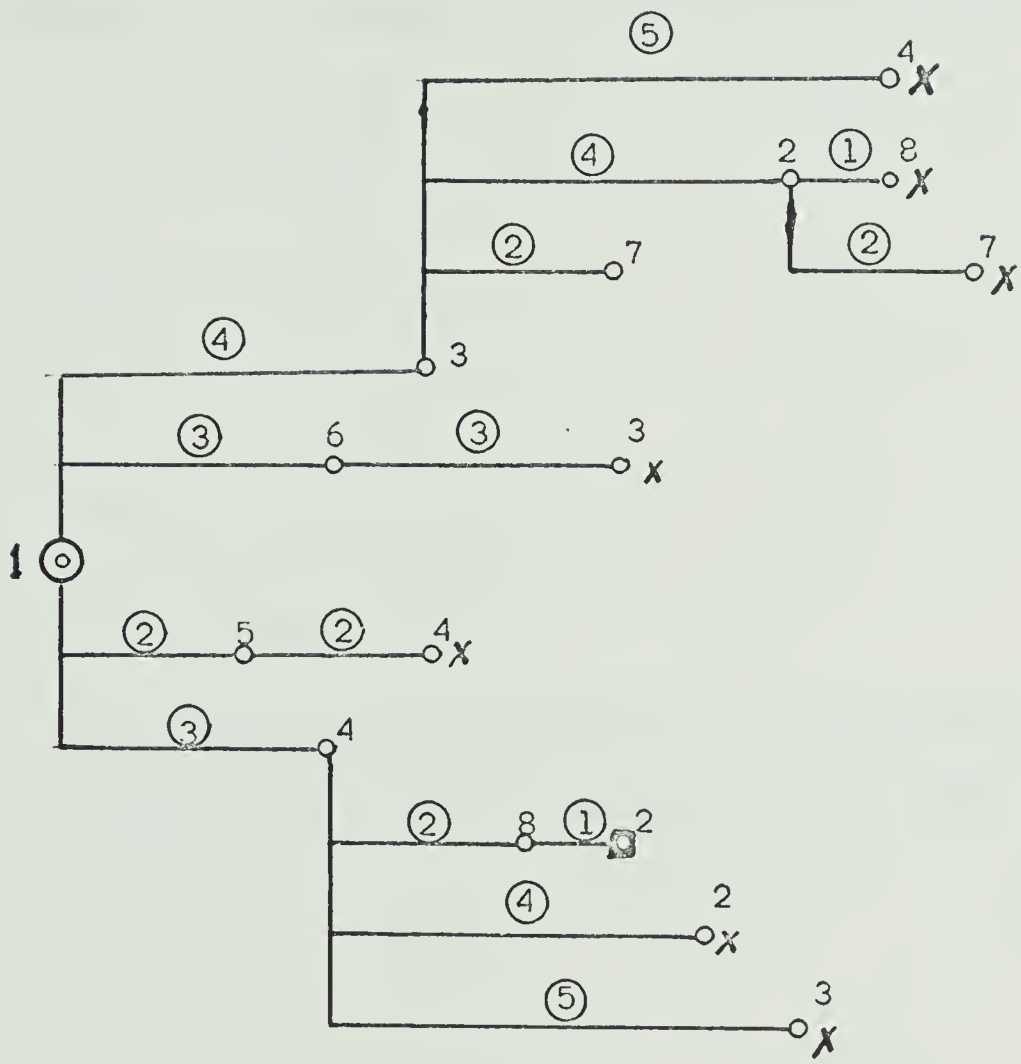
Link	Time	Cum. Time
8-2	1	6
8-4	Reverse	

FIGURE 3.3



The Algorithem has now "built" to nodes 2,7,8, and through nodes 3,6,5, or 4. Consider those nodes which have been built through. Retain the minimum: it is shorter to reach node 3 direct from 1 than via 6 or 4. It is shorter to reach node 4 direct from 1 than via 5.

FIGURE 3.4



Considering those nodes which have been built through retain the minimum.

Origin	Node	Min. Cumulative Travel Time
1	3	4
1	6	3
1	5	2
1	4	3
1	8	5
1	7	6
1	2	6

4. The minimum path from centroid 1 to destination centroid 2 is via links 1-4; 4-8; 8-2; with minimum time 3+2+1 = 6.

APPROACH TO THE PROBLEM

The author's approach to planning can be summarized in three points:

1. Many problems have no unique solution, only an optimization of the parameters affecting the problem.

2. The confidence which can be placed in an optimum solution is proportional to the number of alternatives considered.

3. Reject any solution which cannot be changed if the parameters change, were wrongly interpreted, or if some important aspects were not considered at the time of analysis.

The field of transportation planning is less science than skilled intuition. The sheer magnitude of work involved in testing a transportation network often limits the number of alternatives that can be tested in a practical situation. Increasing the number of alternatives that can be reasonably tested increases the planner's confidence that the optimum solution has been in fact considered, and decided upon.

Rhyason's work investigated the parameters of transportation which make up the Mode Split. This thesis concentrated on the use of these relationships to consider the operating character-

istics, speed, and as many alternatives as possible. The network used in the analysis was constructed to be easily altered and expanded for future testing of alternate systems, and the use of high speed data processing techniques with which the test then was explored. The reader can exercise the third aspect of the previously stated planning approach by rejecting the suggested solution should it appear that significant parameters were erroneously considered or perhaps neglected.

In this investigation, the facilities of the University of Alberta Computing Centre were used. The various programs, both adapted from the work of others, and written especially for this project, can be considered as the "tools" with which the work was done. Details of the significant programs used are contained in the Appendix. Several other programs were used which assisted in testing the network, the data, and correcting data from one form to another.

The "backbone" of the exercise is the tree building program using the Moore Algorithem, and the program which identifies the minimum time path between any origin and destination. The programs used are slight modifications of programs developed by Dr. J. N. Supersad, Post Doctoral Fellow of the Department of Civil Engineering, University of Alberta, 1968. These programs were developed almost concurrently with the thesis work, and were extensively tested on the transit network of this problem. There are, of course, several other

"path-finding" programs in existence, but most were developed for automobile networks and commercial applications where computer time is limited only by cost. The particular programs used are uniquely "general". That is to say they are applicable to a wide range of transportation problems. They are also particularly suited to a research application in that the programs need not be run fully or concurrently, but may be interrupted and re-started, to suit the time available on such a hard-pressed facility as a university computer.

The technique investigated used the traffic zones, origin-destination data, transit network, and observed mode split, relationships of the 1964 Edmonton situation. Some of this data had to be extensively modified for computer application, and the over-riding consideration that the model developed be capable of easy and rapid adaptation to allow future testing of other alternatives.

CHAPTER IV

PROCEDURE

Traffic Zones and Zone Centroids

The traffic zones and traffic districts (FIGURE 2.2) were established by the Metropolitan Edmonton Transportation Study. These zones endeavour to represent a degree of homogenity of land use within the zone and stratifications of that land use are represented by districts within the zone. The original zone and district boundaries were established in 1961 and are generally very representative. Howr-ever, many of the peripheral zones, which were undeveloped and even undesigned in 1961 have either been developed, or more accurately defined by the City of Edmonton General Plan (1968). Future analysis using these zones may require adjusting boundaries in the light of this new information and to be as coincident as possible with census tracts.

The centroid of a zone is assumed to be the point from which all trips originate or to which all trips are destined. They should thus define the "centre of activity" of the zone (U.S. Department of Commerce, 1964). The residential origin zone centroids used were originally established by the M.E.T.S. study. The combined destination zone centroids were established by Rhyason, 1967 (Page 58).

To avoid the possible errors of assigning a zone number to a network node, and since the number of computer iterations are governed by the size of the largest node (or centroid) number, the M.E.T.S. traffic zones are represented by their centroid number. Beginning at 1 for combined destination zone 0010 and 0020, 2 for combined destination zone 0030 and 0040, and continuing consecutively to centroid 141, representing traffic zone 3150, TABLE A.1 and FIGURE 4.1 contain the zone-centroid equivalence and may be used to correlate with Rhyason's work. Note that all M.E.T.S. zones were assigned a centroid number, even if no trips or data exist for 1964. This allows their logical inclusion in any subsequent work. Note also that a gap was left between the last centroid number assigned (141) and the first link number used (200) to allow changing and expanding the zones to suit newly developed areas.

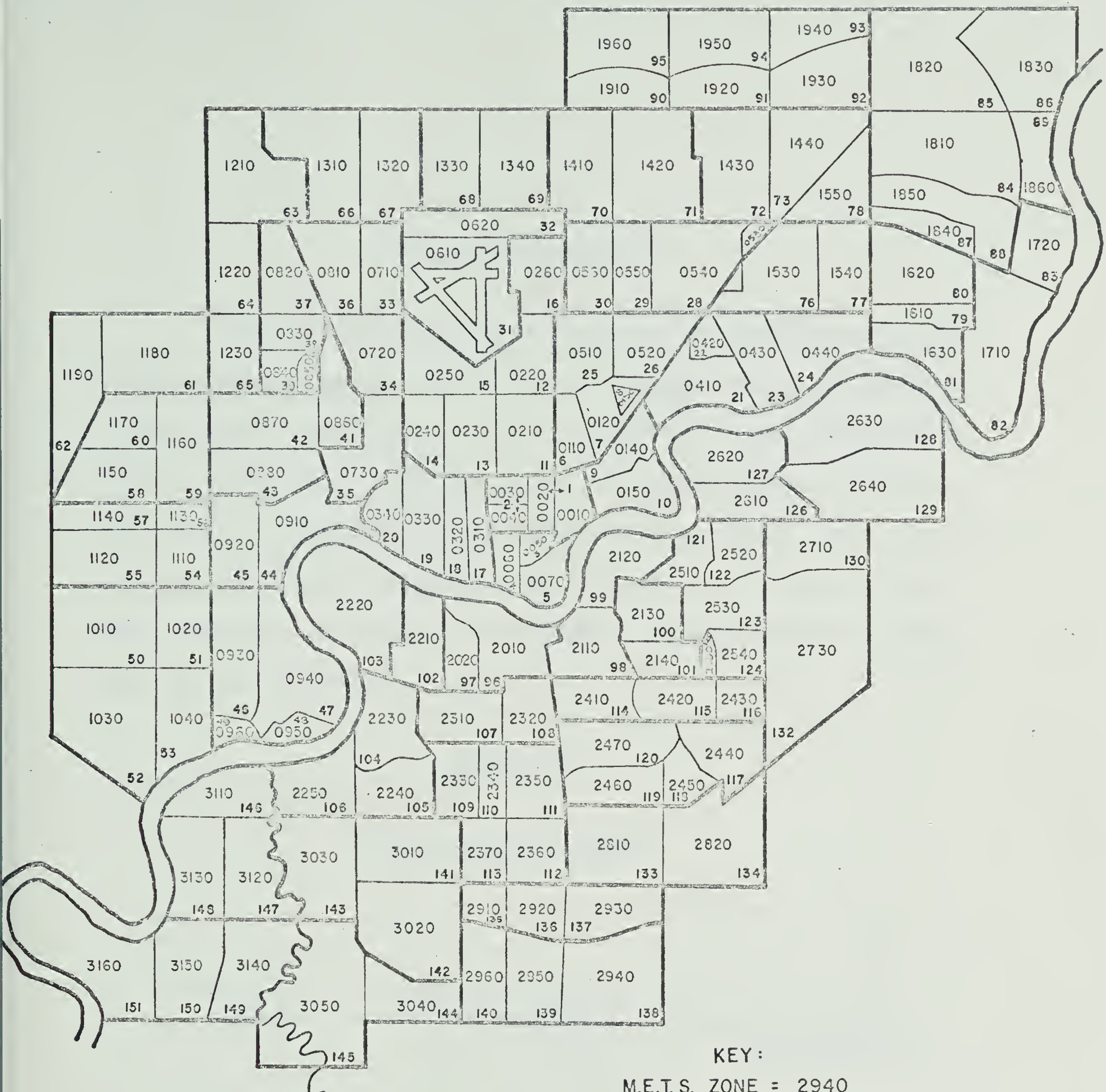


FIGURE 4.1 ZONE-CENTROID EQUIVALENCE.

The Transit Network

The 1964 transit running times used by Rhyason were determined by using schedule time in the morning peak hour, and verified by some riding checks (Rhyason, 1967, page 63). Since the schedule times are for widely separated points, and since Rhyason's analysis considered the total trip times rather than individual link times, an anomaly exists which prevents an exact comparison of the hand and mechanized path assignment. This anomaly is perhaps best described with the aid of FIGURE 4.2.

FIGURE 4.2

HAND ASSIGNMENT ANOMALY

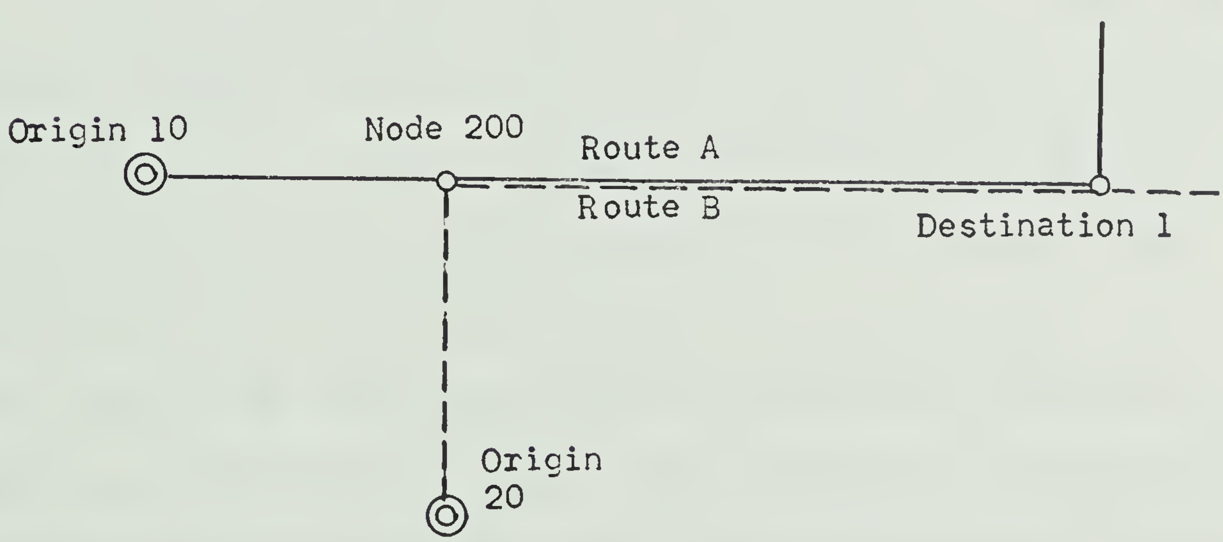


FIGURE 4.2 shows that trips between origin 10 and distination 1 on Route B and origin 20 and destination 1 on Route A are coincident between node 200 and destination 1. By using schedule times it is not impossible to discover a slight difference in time between Route A and B over this link. This is often due to "permissive" or "restrictive" scheduling which encourages drivers to gain time if possible on primarily downtown destined routes, or encourage strict adherence to scheduling on routes which distribute widely and accept and make several transfers.

For adaptation to mechanized assignment, these variations must be rationalized, if possible, to allow one link time (from node 200 to destination 1) to represent the average running time of all routes using the link. This was done with the exception of express buses which were coded as separate links.

The transit network required times between all route intersections, centroid entries and additional "dummy" nodes to allow for future changes to be tested. Schedule timing points are quite far apart and could lead to considerable error if, for example, time were proportioned to the links according to relative length. In actual practice the link times would be obtained from riding time checks on each link of the system. This procedure is beyond both the necessity and resources of this study. The Edmonton Transit System does have checks of actual travel times, made by Inspectors

following in cars. These are routine measurements made to indicate possible improvements and necessary changes in scheduling. These 1964 back files were searched and used where possible to indicate the times on the transit model. These timing points were longer than some individual model links, but were shorter than the published schedule timing points. Intermediate times on model links between timing points were proportioned according to length.

The length of the links in the transit network should, in a practical application, be determined by actual "on the ground" measurement by odometer or similar device. It has been found satisfactory to determine link length by using the average of three automobile runs, measuring the distance to the nearest one hundredth of a mile with the vehicle's odometer, (M.E.T.S. 1961). For this developmental study the link lengths were determined by scaling from a 1" = 1000 ' map and recorded to one one-hundredth of a mile. TABLE B.1 summarizes a field check of the accuracy of scaled measurement as compared to ground measurements. The standard deviation of scaled measurement as compared to ground measurement was 1.3%.

The original intention was to have the entire transit "trip" coded into the network. That is, to have the walking time from the origin to the bus route coded onto a dummy link of zero distance; and to have the waiting time at the bus route also coded on a zero length

dummy link. Since the "tree" program iterates according to the number as well as size of nodes and links, it was thought necessary to have the centroid replace a node directly at the point of entry onto the system, with the walking and waiting time brought into the analysis as constants in a later program. This did help reduce the computer time, but as the program was improved, time was not a problem. Toward the end of the analysis, as various transit alternatives were tried, it was found that the original idea of having dummy links to represent the components of excess time would have been desirable. Time did not permit re-coding the network, but the procedure of coding excess time as dummy links is recommended for any future work where testing alternatives is involved. (FIGURE 4.3).

Actually, there was an attempted run prior to the reported run 1, which contained the "dummy" walks and waits as previously described. This could be called run 0. It was attempted, using a minimum path program obtained from the Alberta Department of Highways, but the unmodified "tree building" program could not cope with the problem in the available computer time, so this approach was dropped and origin centroids inserted directly into the transit network. The program was subsequently modified to build trees only from desired origins to desired destinations, and not all other nodes. Another modification to the conventional tree building program was to have the various iterative steps monitored by

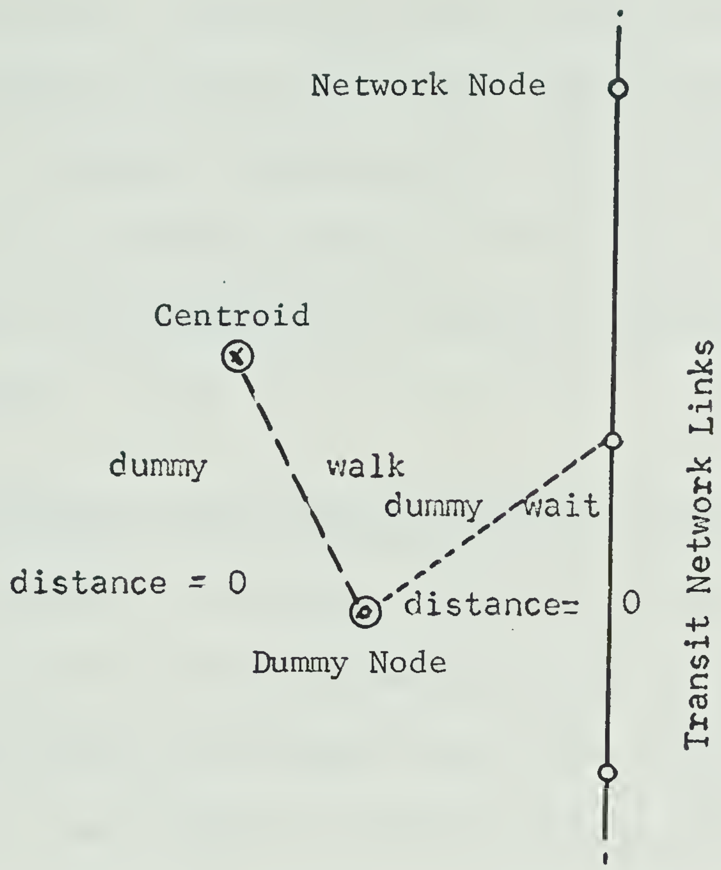


FIGURE 4.3 - DUMMY EXCESS TIME LINKS CODED INTO NETWORK

internal counters. Conventional Moore Algorithm programs iterate up to the highest of the various input number series used for node numbers, link numbers, centroids, etc. The modification saved computer time by counting actually used values in the various number series, and skipping the iterations where gaps in the number series existed.

Available tree building programs required the most vigilant attention to coding: Continuous number series for links, nodes, centroids, etc. with rigorous accounting for all gaps. For example, in previous programs the network would have to be coded with centroids beginning at 1 and numbering consecutively to the end of the centroids, say to the mid 100's. If a gap were left and the nodes were begun at 200 series to 500 series, 700's used for dummy walks, and 800's used for dummy waits, the computer would iterate 800 odd times for a network of 500. With the new tree program, the only restriction is that the network be complete, with no dead ends, and that desired origins and destinations be listed.

These modifications were made largely by Dr. J. N. Supersad, although the author can take credit for developing a pesky enough network with which to identify problems and test the modifications.

The network data was coded according to the format illustrated in TABLE IV.2. A simple check was performed by means of a manipulative

TABLE IV.2

CARD FORMAT FOR NETWORK DATA

Column	Identification
3,4,5	Origin Node
8,9,10	Destination Node
16,17,18,19,20	Link Time to one tenth of a minute
26,27,28,29,30	Link Length to one hundredth of a mile
33,34,35	Link number

program used to calculate the speed on each link and identify extremely low and high speeds. These links were re-examined and either the length adjusted or the time redistributed until no glaring errors were apparent. An example of this network data is summarized in TABLE B.2. The 1964 Edmonton Transit network to the C.S.A. is shown in FIGURE F.1.

The network, must of course, contain the transfer times as part of the system. Test network 1 does not, however, contain all the transfer possibilities. A partial trial including actual 1964 transfer points was begun, but was discontinued when visual inspection indicated some trip paths not borne out by the experience of the transit system officials. Typically these involved "back" trips and multiple transfers to use express buses which do not actually occur. This seemingly arbitrary inclusion of some transfers and exclusion of others represents an attempt to reflect the attitudes and habits of transit patrons who are observed by Transit Inspectors to transfer to reach a point not accessible by the original route, but rarely give up a seat on a warm bus to transfer to another bus going to the same place. To facilitate coding and subsequent identification, all transfers are coded as dummy links of length 0, with the origin node in the 600 series.

The walking time at the end of the transit trip to the destination proved to be another problem. In Rhyason's "hand" analysis he was able to use the destination walking time as determined

by M.E.T.S. These were determined by questionnaire, and result in the statistically correct but mechanically impossible situation where the destination walking time between a bus stop and a destination can be different for trips from each origin. In this "mechanical" analysis, destination walking times were averaged for each significant terminal system point, and the destination walking time is included in the system as a "dummy" link of zero length. TABLE IV.3 shows the destination walking times for the downtown destinations considered.

TABLE IV.3

DESTINATION WALKING TIMES

Destination Centroid	Zone	From	To	Time (Minutes)
1	0010 & 0020	Jasper & 100 St.	Jasper & 100 St.	3.0
1	0010 & 0020	100 St. & 102 Ave.	Jasper & 100 St.	4.0
2	0030 & 0040	Jasper & 107 Ave.	North of Jasper	3.0
2	0030 & 0040	102 Ave. & 107 St.	North of Jasper	4.0
2	0030 & 0040	102 Ave. & 105 St.	North of Jasper	6.0
3	0060	109 St. & 87 Ave.	Gov't. Centre	3.0

The 1964 Edmonton Transit network was run through the "tree building" program, number 1. A listing of this program is included in TABLE C.1 and is described in detail by Supersad, 1968. This program requires the following input.

1. Control Card

TABLE IV.4

Card Format - Control Card for Tree Building Program

Column	Variable Name	Identification Variable Definition
2,3,4	LNK	Number of Links in network.
6,7,8	NOR	Number of Origin Centroids from which trees are to be built.
10,11,12	NOD	Maximum number of nodes. This is not essential but makes one check dimensions.
14,15,16	LFT	Constant to set value of time factor. In this case minimum time path is used so set LFT = 600
18,19,20	LFD	Constant to set value of distance factor. In this case minimum time path is used so set LFD = 0
22,23,24	NOC	Control of interrupt. NOC = 0 for initiation. NOC = 1 if program has been interrupted.
26,27,28	NPR	Control of interrupt. NPR = 2 if program is not to be interrupted.

Column	Variable Name	Variable Definition
30,31,32	NTA	Tape output control. NTA = 2 tree data is to be put on tape.
34,35,36	NHN	Highest node number
38,39,40	LHN	Highest Link number
42,43,44	KZA	Node counter. KZA = 0 for initiation; KZA = KZA of interrupted program when required to re-start.

2. Network Data. (See TABLE IV.2)

3. Destination Control.

   Card 1. - Controls number of destinations to which trees will be built.

Column	Variable Name	Definition
2,3,4	NCD	Number of destinations to be considered.

   Card 2. - Lists destinations to be considered in I4 format up to NCD destinations.

4. Lists of Origins - Controlled by NOR, one origin centroid per card in I5 format, variable is named NNT. If it is desired to interrupt the program before building all the trees, for example to stay within time limitations, put NNT - 9998 in I5 position, to stop the program set NNT - 9999.

FIGURE 4.4 shows the deck composition of the Tree Building Program No. 1.

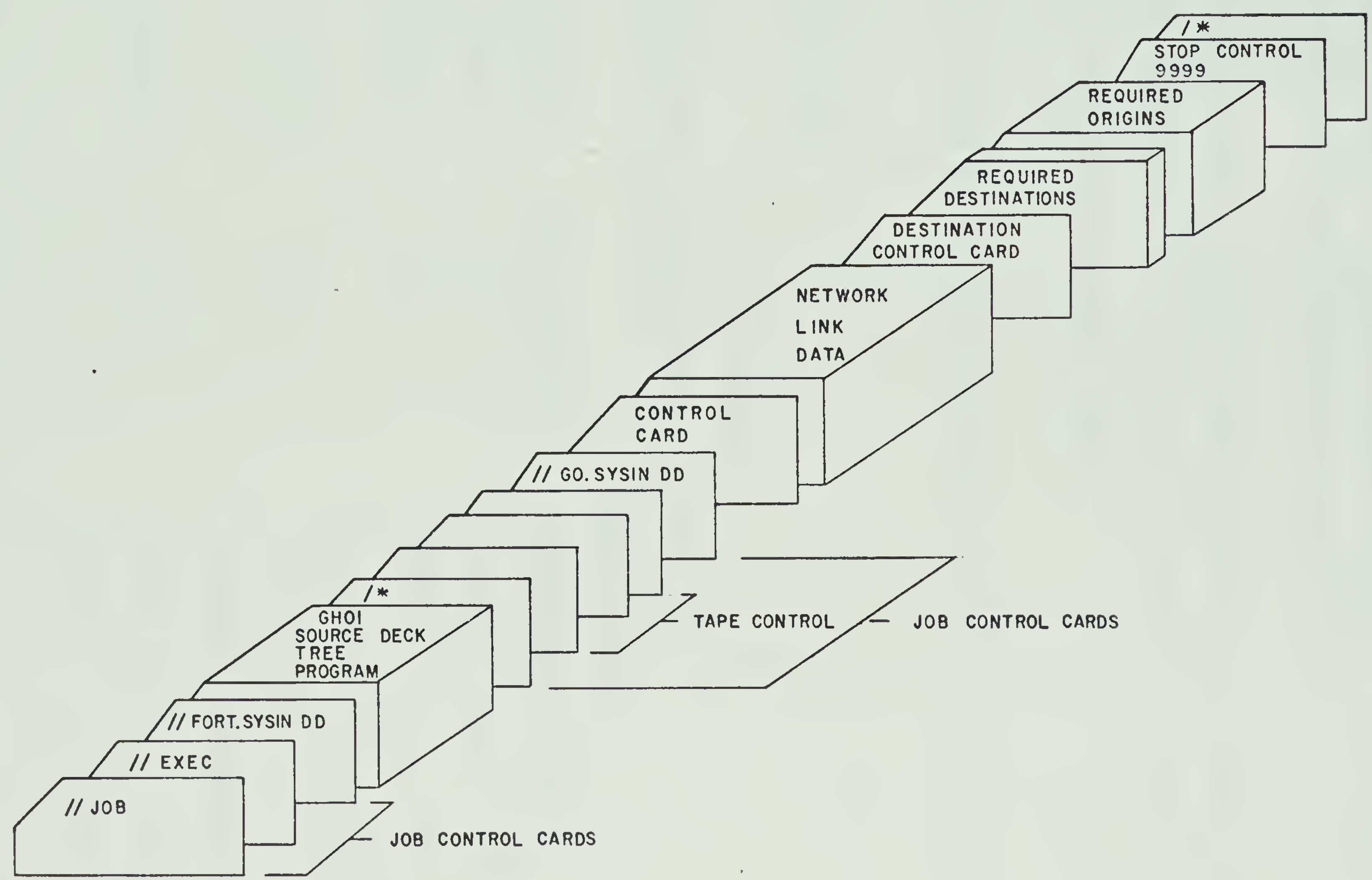


FIGURE 4.4 DECK COMPOSITION - TREE BUILDING PROGRAM NO. I

A sample output of the tree building program 1 is included in TABLE IV.5. FIGURE 4.5 shows the tree for origin 141.

The 1964 Edmonton Transit network was then run through the "Minimum Path" program, No. 2. A listing is included in TABLE C.2 and is described in detail by Supersad, 1968.

The following is a list of required input for the minimum path program:

1. Control Card

TABLE IV.5

Card Format - Control Card for Program 2

Column	Variable Name	Identification Variable Definition
2,3,4	LNK	Number of Links in network.
6,7,8	NOD	Number of nodes. This is the KZA value from program 1.
10,11,12	NPR	Print control. NPR = 2, Path data will be printed.
14,15,16	NPU	Punch control. NPU = 2, Path data will be punched. (This is used for input to program 5)
18,19,20	NOC	Counter. NOC = 0 for initial run. NOC - number of trips done previously if program re-started.

Column	Variable Name	Variable Definition
28,29,30	NOB	Counter
38,39,40	NDD	Total distance counter
		NND – 0 for initial run.
48,49,50	NTT	Total time counter
		NNT – 0 for initial run.
58,59,60	NTC	Total cost counter
		NTC – 0 for initial run.
62,63,64	LHN	Highest Link number
66,67,68	NHN	Highest Node number
70	NPW	Punch control.
		NPU – 2, punch loaded network.
72	NPZ	Print control. NPZ - 2,
		print loaded network.

2. Network data - Same as used in first program. See TABLE IV.2

3. Tree data - n tape. Produced by program 1.

4. Transit Trip data

SAMPLE OUTPUT OF TREE BUILDING PROGRAM

PAGE 34

ORIGIN CENTROID 131 37 LINKS

DEST. NODE	CUM. TIME	LAST LINK	DEST. NODE	CUM. TIME	LAST LINK	DEST. NODE	CUM. TIME	LAST LINK	DEST. NODE	CUM. TIME	LAST LINK	DEST. NODE	CUM. TIME	LAST LINK	DEST. NODE	CUM. TIME	LAST LINK
371	319	553	372	294	552	380	182	380	381	175	381	394	224	14	388	154	13
390	185	631	441	44	529	443	17	533	477	137	386	528	193	7	529	209	65
532	193	147	533	186	392	535	231	357	557	167	378	606	167	379	610	244	557
611	209	660															

EQUAL COST ROUTE FROM NNT TO NN VIA THIS LINK OMITTED
ORIG DEST LINK
141 493 593

ORIGIN CENTROID 141 41 LINKS

DEST. NODE	CUM. TIME	LAST LINK	DEST. NODE	CUM. TIME	LAST LINK	DEST. NODE	CUM. TIME	LAST LINK	DEST. NODE	CUM. TIME	LAST LINK	DEST. NODE	CUM. TIME	LAST LINK	DEST. NODE	CUM. TIME	LAST LINK
1	310	8	2	357	356	4	275	554	97	243	429	113	50	548	141	0	0
349	287	352	350	280	351	361	296	353	363	306	354	365	317	62	367	295	407
368	300	659	371	245	404	372	270	406	385	255	366	386	245	366	387	234	365
480	200	364	481	195	363	432	170	415	494	40	547	496	95	450	498	117	436
493	16	546	501	139	438	504	126	458	509	152	424	512	159	425	528	280	370
523	296	66	535	317	61	560	200	405	561	139	423	562	206	427	563	76	454
564	97	457	607	171	426	608	76	455	610	285	653	611	296	660			

PROGRAMME COMPLETED
412 94 500 600 0 94 2 2 611 681 340

University of Alberta
Department of Computing Science

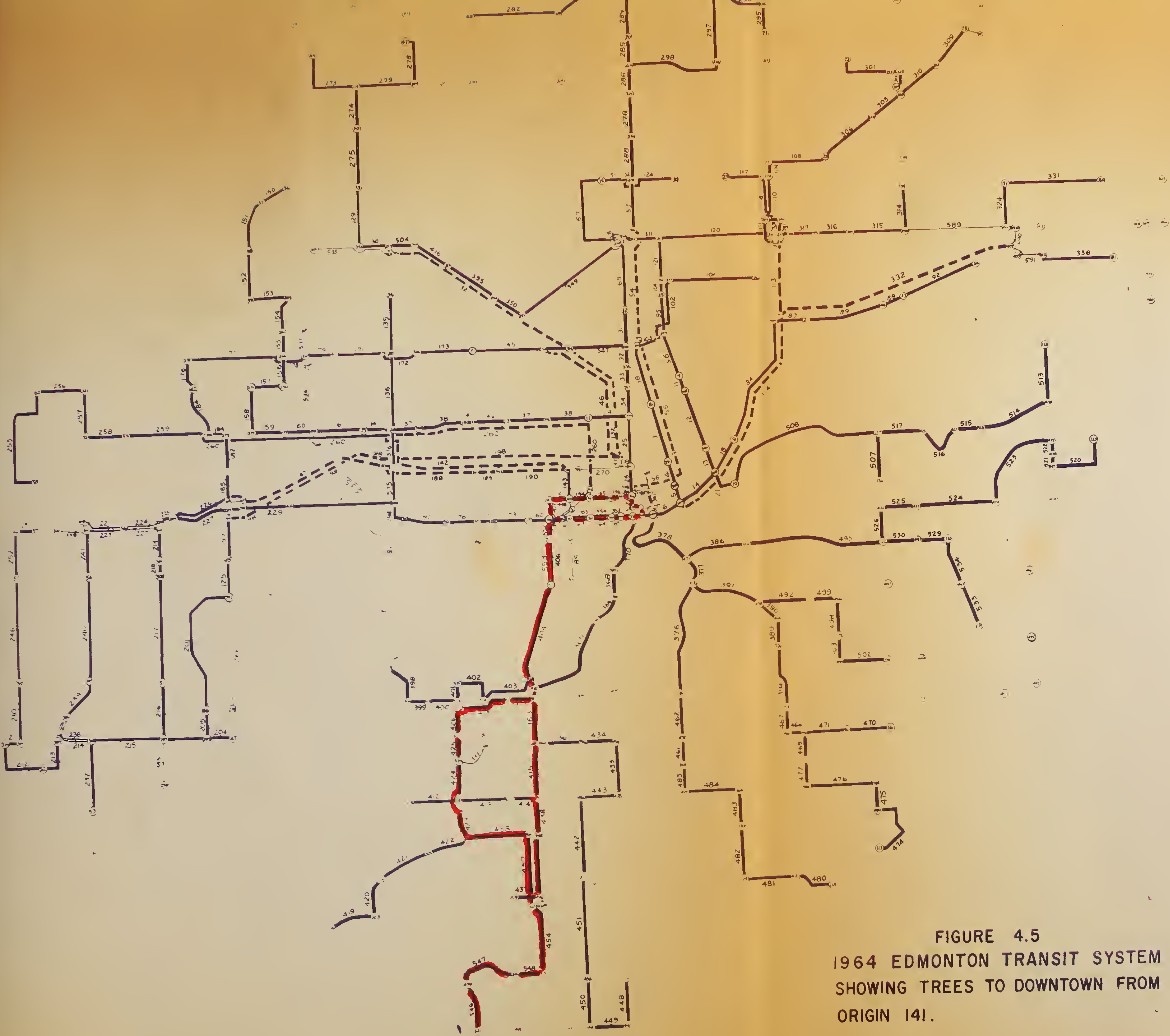


FIGURE 4.5
1964 EDMONTON TRANSIT SYSTEM
SHOWING TREES TO DOWNTOWN FROM
ORIGIN 141.

TABLE IV.7

Card Format - Transit Trip Data for Program 2

Column	Variable Name	Identification Variable Definition
1,2,3,4	NTO	Origin Centroid
5,6,7,8	NTD	Destination Centroid
11,12,13,14	NTM	Number of Transit Trips from NTO to NTM

Note: Transit trips between each origin and destination in the above format were prepared by a small "manipulative" program from O.D. data and observed mode split. Each data card is followed by an interrupt control card. If N.T.O. - 9997, program will continue. If NTO - 9996, program will interrupt at that point. If NTO - 9999, program will stop. This is a rather clumsy section of the Minimum Path Program and would require modification for most other applications.

FIGURE 4.6 shows the deck composition of the Minimum Path Program No. 2. A sample of the output of the minimum path program No. 2 is included in TABLE IV.8, FIGURE 4.7 shows the minimum time path from origin 141.

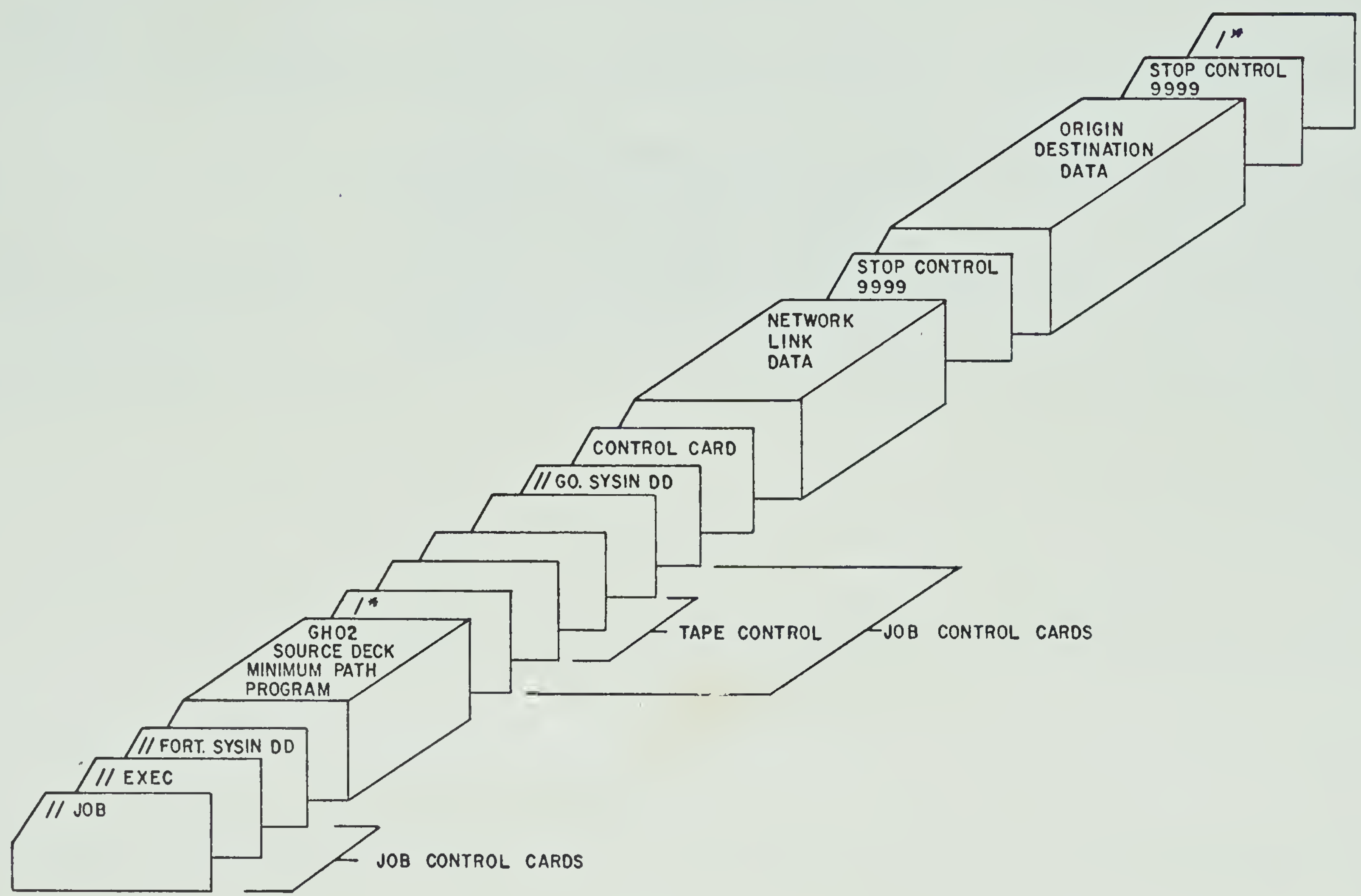


FIGURE 4.6 DECK COMPOSITION – MINIMUM PATH PROGRAM NO. 2

TABLE IV.8

SAMPLE OUTPUT OF MINIMUM PATH PROGRAM

1964 EDMONTON BUS TRANSIT - WITH LOOP RAPID TRANSIT SYSTEM SUPERIMPOSED

ORIGIN CENT.	DEST. CENT.	NO OF LINKS	TRIP TIME	TRIP LENGTH	----LINK----- NO.	TIME	DIST	----LINK----- NO.	TIME	DIST	----LINK----- NO.	TIME	DIST
141	1	10	20.0	5.11									
					649	4.0	0.0	619	1.2	0.34	618	1.1	0.24
					616	1.4	0.53	614	1.9	1.04	612	1.2	0.36
					610	1.8	0.93	608	2.2	1.36	600	3.6	0.0
					546	1.6	0.31						
141	2	9	17.8	4.77									
					648	3.0	0.0	618	1.1	0.24	616	1.4	0.53
					614	1.9	1.04	612	1.2	0.36	610	1.8	0.93
					608	2.2	1.36	600	3.6	0.0	546	1.6	0.31
141	4	7	15.3	4.00									
					646	3.0	0.0	614	1.9	1.04	612	1.2	0.36
					610	1.8	0.93	608	2.2	1.36	600	3.6	0.0
					546	1.6	0.31						

PROGRAMME COMPLETED

FIGURE 4.7
RUN 3
1964 EDMONTON TRANSIT SYSTEM
WITH LOOP RAPID TRANSIT SUPERIMPOSED
SHOWING MINIMUM PATH TO DOWNTOWN FROM
ORIGIN 141.

The transit trip time recorded in the output includes transit running time, transfer time, and walking time at the destination. It does not include walking time at the origin, or waiting time. TABLE IV.9 summarizes the mechanically established minimum transit trip time as compared to Rhyason's more rationalized assignment , for a sample of the origins. These differences led to a digression into the effect this difference would have on the Mode Split analysis.

TABLE IV.9

Example of Difference in Transit Trip Time by Hand and Mechanical Assignment

Centroid	Total Time to Destination 1: Hand Assignment	Mechanical Assignment
6	14.8	17.1
7	16.4	15.8
9	15.4	15.3
10	18.1	18.7
11	15.6	16.4
12	29.1	19.9
13	23.2	23.1
14	23.8	23.7
15	24.7	21.2
16	25.7	25.2
17	13.6	15.0
18	14.9	16.1
19	16.9	17.7
20	20.8	19.5
21	22.7	21.8
23	23.8	25.1
24	29.3	29.6
25	21.9	21.0
26	26.6	28.3
28	30.3	31.3
29	36.0	37.6
30	31.9	26.9

In order to test the effect of mechanical assignment on the Mode Split analysis, as well as the effect of the anomalies of network assignment discussed previously, a computer program was developed which essentially develops the mode split curves by Rhyason's method. This program is described and listed in APPENDIX D. From this work it is concluded that there is a difference in the mode split relationships if the network is analyzed mechanically. The analysis did suggest that Rhyason's sample size was a little too small to justify the extrapolated curved portions of the mode split graphs.

FIGURES 4.8 to 4.12 compare Rhyason's hand fitted Mode Split curves (solid line) the best fit line by regression analysis. One line (long dash) uses Rhyason's data and is indicative of the difference between hand and mechanical curve fitting. In some cases there was good agreement, and in some places the curves are not similar. This was not intended to be a critique of Rhyason's curves, although the conjecture about the curved portions of his graphs seemed to be borne out by subsequent developments described in Chapter IV, Item 7, as Identification and Removal of outliers. The third line on the graphs (long and short dashed) is the regression line representing the transit trip data developed by the mechanical path finding procedure, the coding anomaly, and the destination simplification described previously. While these do vary, compared to Rhyason's curves, there is a distinct

relationship to the line using Rhyason's data with the same analysis. This was sufficient to allay the Author's fear that hand fitted mode split curves are incompatible with mechanical network analysis.

The next step was to determine the speed each link of the network would have to run in order to provide various uniform levels of transit service, as measured by mode split. Program number 5, "Required Speed" was developed to do this. The program is described in some detail so that any future work in this line can avoid the same mistakes.

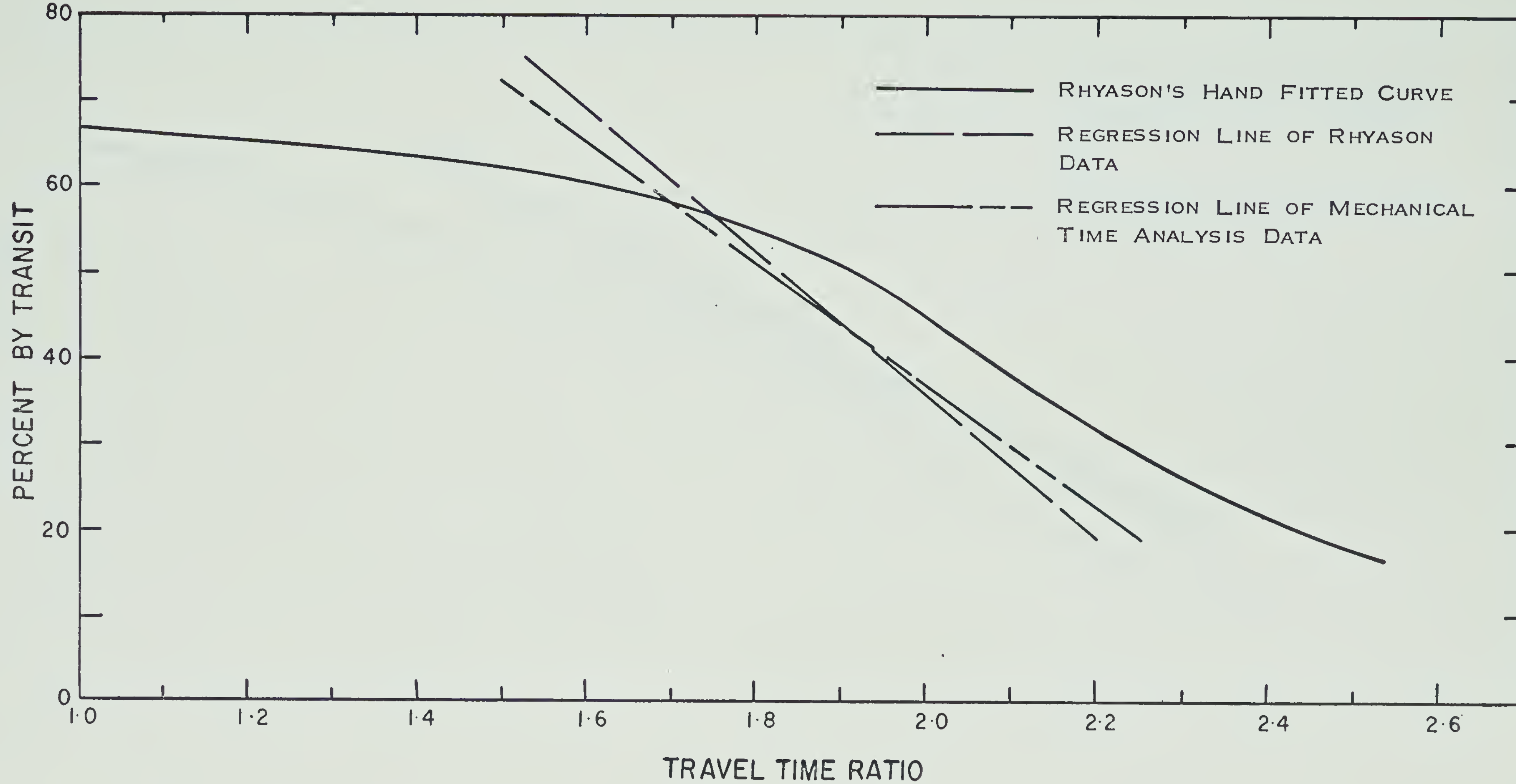


FIGURE 4.8 1964 MODAL SPLIT RELATIONSHIPS TO CENTROID I
HOUSE VALUE LESS THAN $11,000

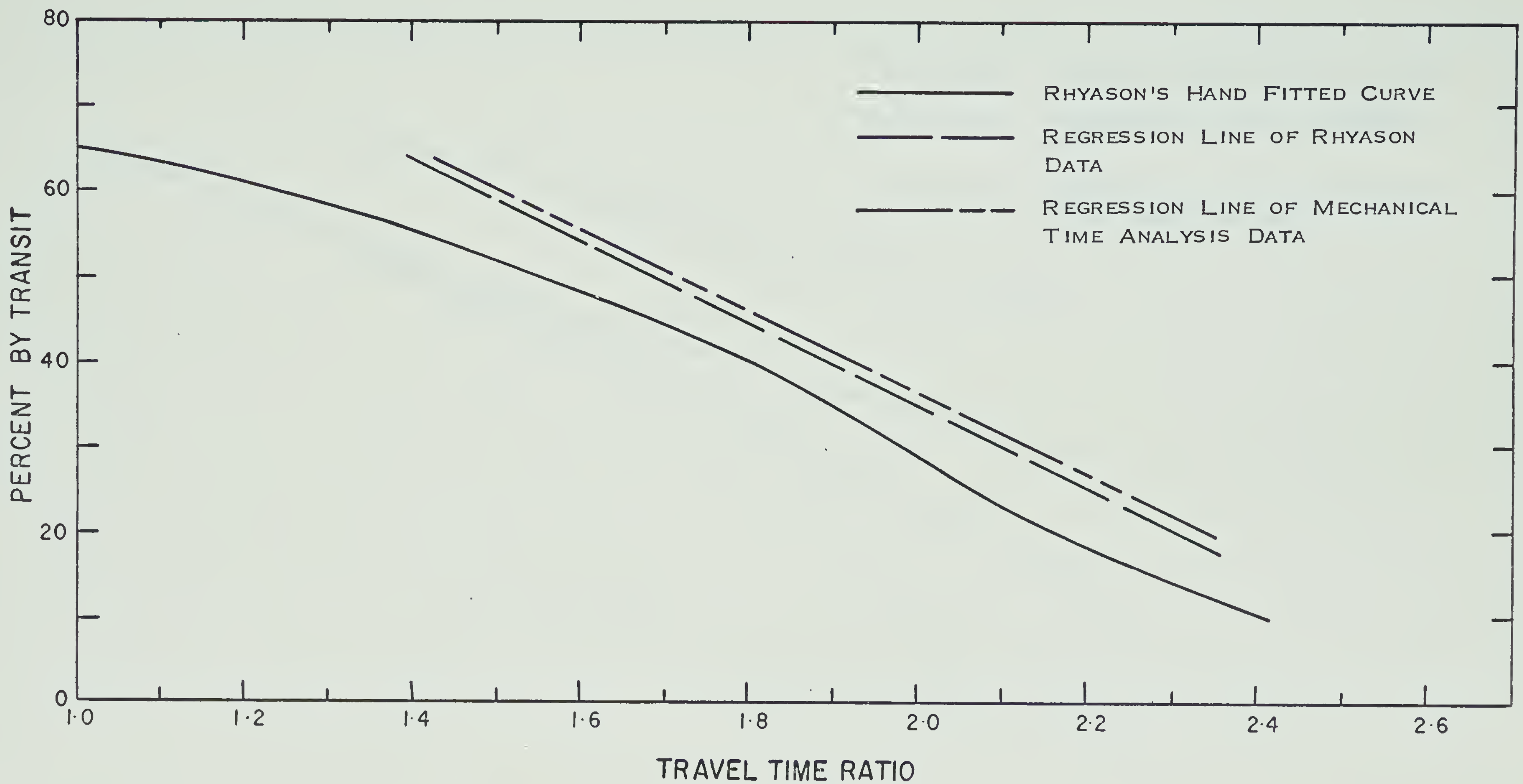


FIGURE 4.9 1964 MODAL SPLIT RELATIONSHIPS TO CENTROID I

HOUSE VALUE \$11,000 TO \$14,000

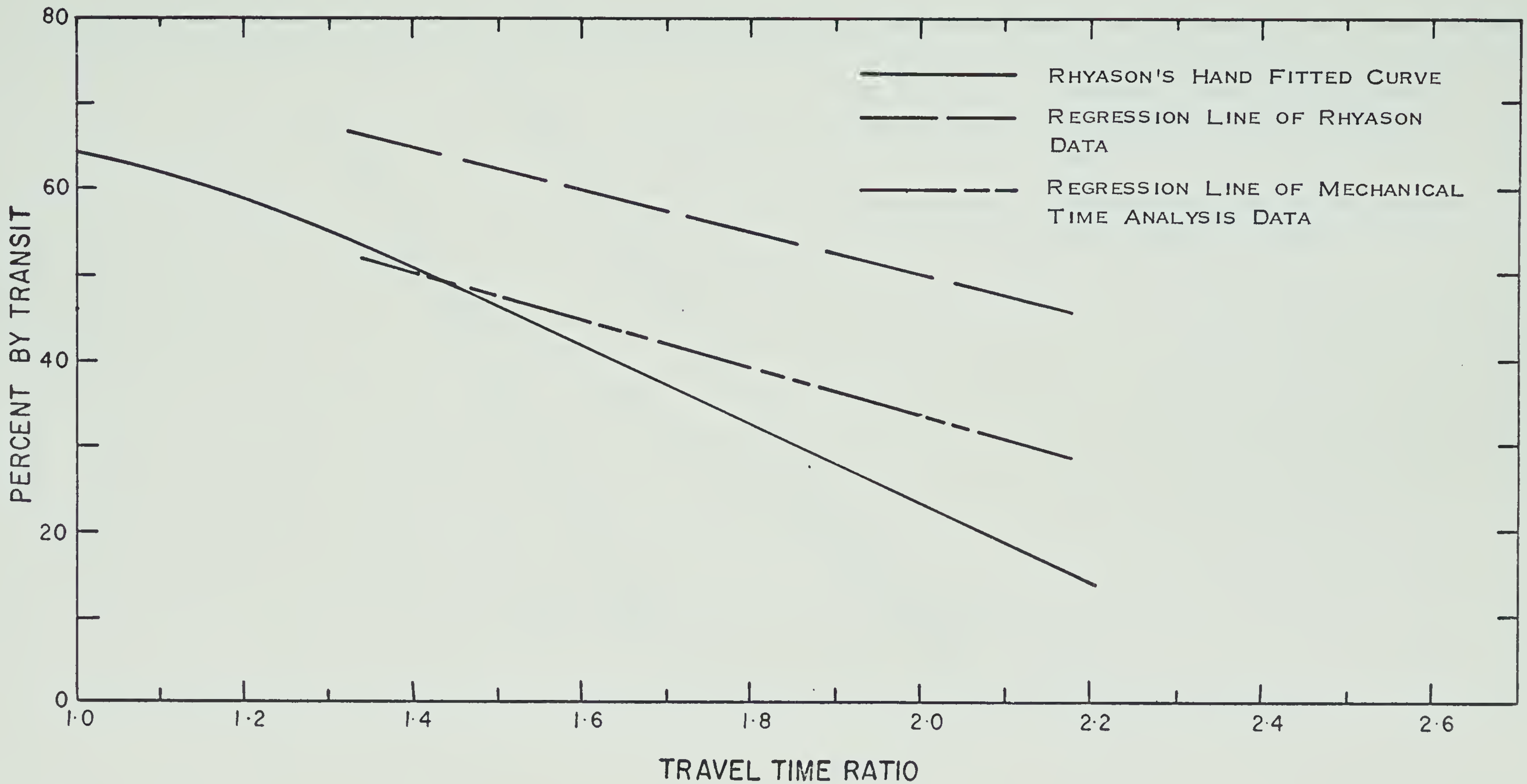


FIGURE 4.10 1964 MODAL SPLIT RELATIONSHIPS TO CENTROID I
HOUSE VALUE $14,000 TO $17,000

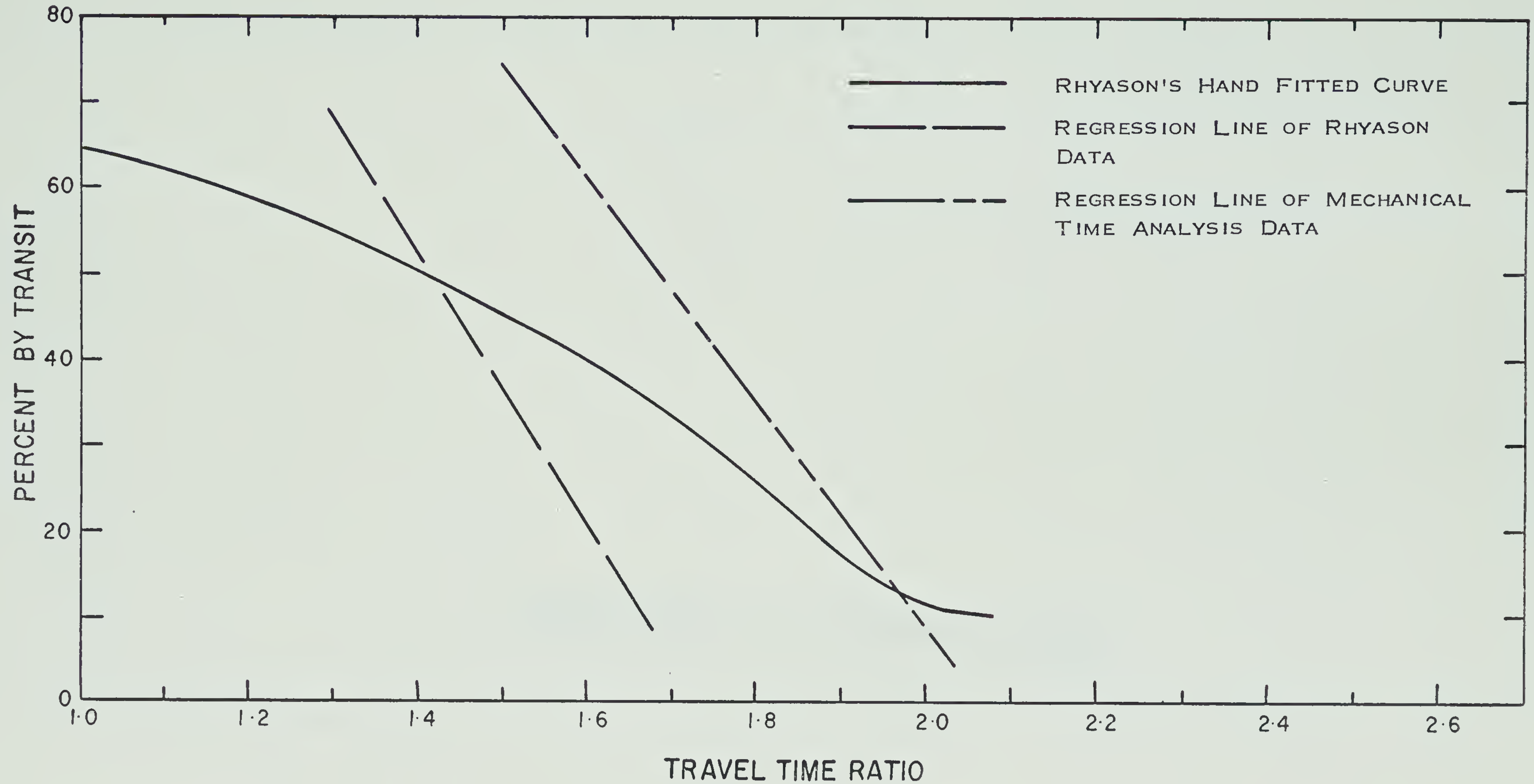


FIGURE 4.11 1964 MODAL SPLIT RELATIONSHIPS TO CENTROID I
HOUSE VALUE $17,000 TO $22,000

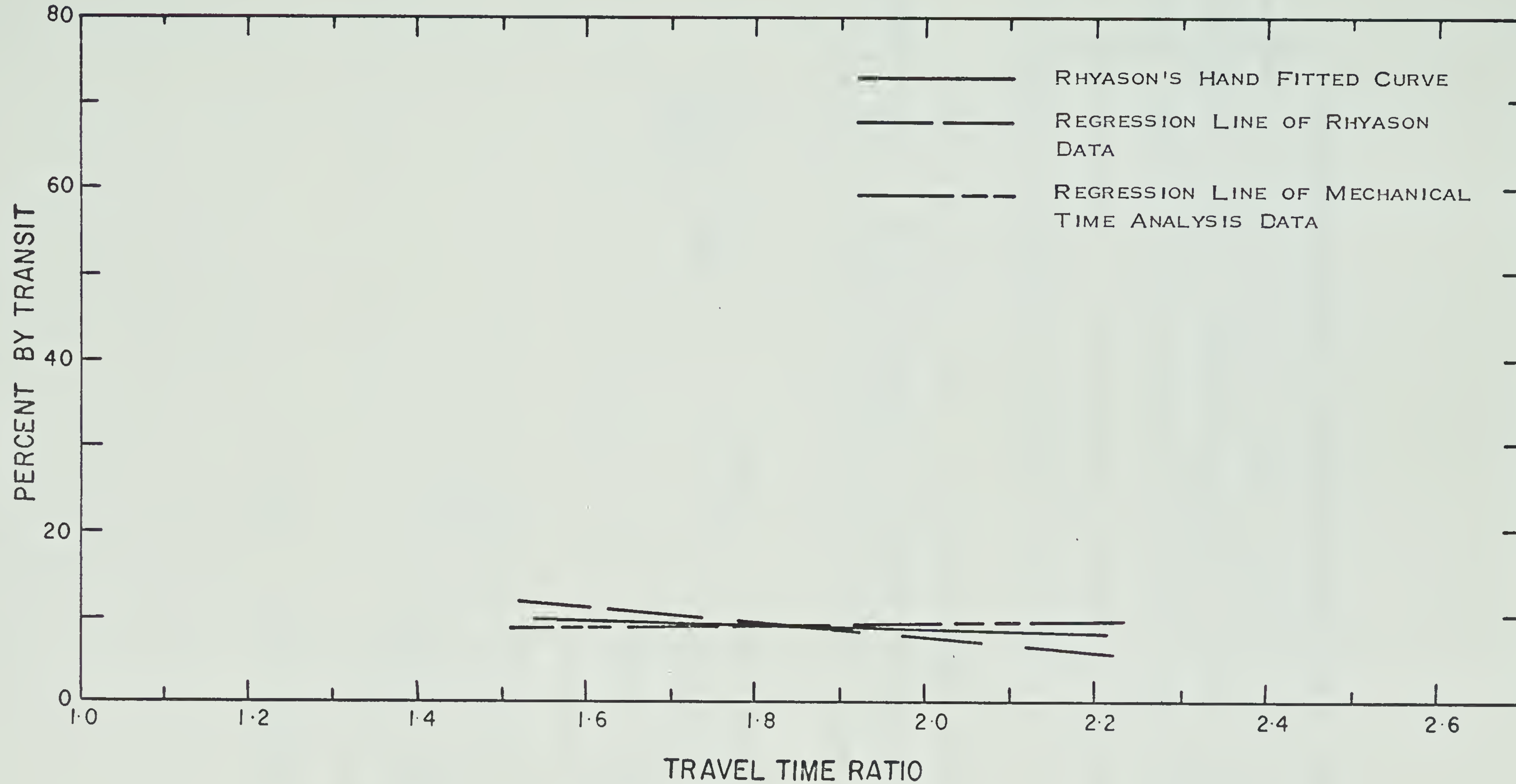


FIGURE 4.12 1964 MODAL SPLIT RELATIONSHIPS TO CENTROID I

HOUSE VALUE GREATER THAN $25,000

The program requires an established mode split relationship and automobile travel time data in order to establish the total transit time required to attract a desired percentage of transit riders. In this test, Rhyason"s Travel Time Ratio curves were used, although Travel Time Difference, or the mechanically determined straight line diversion curves of APPENDIX C could have been used.

Ideally, one would wish to consider a single transit route from each origin to each destination. The speed at which such a route would have to operate to attract M% of transit riders would be:

$$S_{M_{ij}} = \frac{LT_{ij} \quad TTR_{ij}}{AT_{ij}}$$

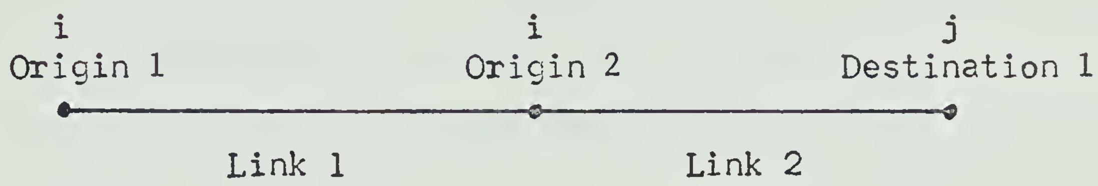
where S_M = Speed required to attract M% riders to transit from origin i to destination j.

LT_{ij} = length of transit trip

TTR_{ij} = Travel time ratio
= Transit travel time divided by auto travel time.

AT_{ij} = Auto travel time.

This idealized situation is not the case in a real transit network, where one route serves several origins and destinations. Consider a single route of 2 links serving 2 origins and 1 destination.



Link 1 - The speed required at mode split level M is governed by the transit trip time which would attract M% transit riders between

$i = 1$ $\qquad j = 1$

Link 2 - The speed required is governed by the transit trip time which would attract M% transit riders between $i = 1$, $j = 1$, or $i = 2$, $j = 1$, whichever is the least time.

The above is the simple principle which was used in the "Required Speed" program. A listing and the flow chart of the program are contained in APPENDIX E.

The following is a description of the required input for Program 5, "Required Speed", as well as a general description of the function of significant areas of the program.

1. Control Card

TABLE IV. 10

Card Format - Control Card for Program 5, "Required Speed"

Column	Variable Name	Identification Variable Definition
2,3,4,5	NOR	Number of origins
7,8,9,10	NDST	Number of destinations
12,13,14,15	IRUN	Run number
17,18,19,20	IYEAR	Year of network
22,23,24,25	ICTL	Controls "sort" portion of program. If ICTL = 1, program will print links in ascending order of Load. If ICTL = 0, program will skip this section.
27,28,29,30	ITEST	Percentage increase in speed desired to be tested
32,33,34,35	LKHI	Highest link number
37,38,39,40	NORDER	The number of origin-destination combinations governing the required speed whichever desired to be output (1 to 6).

Run 0 - Test run

Run 1 - 1964 Edmonton Transit Network

Run 2 - Test run

Run 3 - 1964 Edmonton Bus Transit - with loop rapid transit superimposed (Bakker, 1968)

Run 4 - 1964 Edmonton Bus Transit - With C.N. rapid transit superimposed (described on T.V., 1968).

2. Mode Split - travel time relationship.

TABLE IV.11

Card Format - Mode Split Data for "Required Speed" Program

		Identification
Column	Variable Name	Variable Definition
2,3,4,5	L	House Value Group * (Rhyason, 1967)
7,8,9,10	TTR (L,M_2)	Travel time ratio, for L,M - 20%
12,13,14,15	TTR (L,M_3)	Travel time ratio, for L,M - 30%
. . . . .	. . . .	. . . .
. . . . .	. . . .	. . . .
27,28,29,30	TTR (L,M_6)	Travel time ratio, for L,M - 60% *

* - The range of mode split from 20% to 60% covers the majority of Edmonton situations.

3. Initialization, Statement 10 to Statement 7

4. Travel Parameter Data.

House value, Transit Excess time, Auto Time, O - D.

This data was produced by a compression of data used in the Mode Split program, and is essentially a summary of finding by Rhyason, 1967.

TABLE IV.12

Card Format - Travel Parameter Data for "Required Speed" Program

Column	Variable Name	Variable Definition
2,3,4,5	IDST	Destination centroid
7,8,9,10	IOR	Origin centroid
12,13,14,15	IHVG (IDST,IOR)	House Value group
17,18,19,20	TTT	Total Transit Time *
22,23,24,25	WALKO	Walking time from origin to transit stop
27,28,29,30	WAIT	Waiting time
32,33,34,35	TRANS	Transfer Time **
37,38,39,40	WALKD	Walking time from transit stop to destination ***
42,43,44,45	ATT	Auto travel time
47,48,49,50	BP	Bridge penalty
52,53,54,55	TRIP	Total trips between origin IOR and destination IDST

Column	Variable Name	Identification Definition
57,58,59,60	MSO	Observed Mode Split
62,63,64,65	IHV	House Value in Dollars

* - TTT - From Rhyason, 1967, Not used in this program.

** - TRANS - from Rhyason, 1967, Not used in this program.

*** - - WALKD - from Rhyason, 1967, Not used in this program.

5. Transit trip data.

(Output from Program 2, "Minimum Path")

This is a multi-card format. The first card identifies the origin and destination of the trip, the number of links in the trip, the total time and total length of the trip. The number of links specified on this card controls the reading of subsequent link data cards involved in that particular trip.

TABLE IV.13

Card Format - Transit Trip Data and Link Control for "Required Speed Program"

		Identification
Column	Variable Name	Definition
2,3,4	IORTPE	Origin centroid
6,7,8	IDSTPE	Destination centroid
13,14,15,16	LINKS	Number of links in trip from IORTPE to IDSTPE (controls subsequent link cards for this trip.
21,22,23,24	ITIME	Transit time for trip from IORTPE to IDSTPE (x 10) (includes running time, transfers, walking at destination)
29,30,31,32	ILNTH	Trip length (x 100)

TABLE IV.14

Card Format - Transit Link Data for "Required Speed" Program

Column	Variable Name	Identification Definition
2,3,4,5	LNK(K)	Link number (K = 1)
7,8,9,10	LT (K)	Link time (x 10) (K = 1)
12,13,14,15	LL (K)	Link length (x 100) (K = 1)
. . . . .	. . . .	. . . .
. . . . .	. . . .	. . . .
62,63,64,65	LNK (K)	Link number (K = 5)
67,68,69,70	LT (K)	Link time (K = 5)
72,73,74,75	LL (K)	Link length (K = 5)

(Continues on subsequent cards until K - LINKS from transit trip data (control) card.

6. Identify and remove the "transit impossibles"

As was obvious from the Mode Split graphs (FIGURES 4.12, 4.17, 4.21) the highest house value group have such a flat mode split-travel time ratio curve, that even infinitely fast transit trips could not significantly increase the transit ridership beyond its present (10%) - approximately. For this reason, origins in the greater than $25,000 house value group were excluded from the analysis.

7. Identify and remove "outliers"

As can be seen from the Mode Split Graphs (FIGURES D.6 D.8) the individual mode split-travel time ratio points have considerable scatter about the smoothing line. Trying a mode split higher than observed could result in a Travel Time Ratio (TTR) of less than 1. These questionably small values resulted in impossibly high link speeds on the test runs: in the order of 300 to 400 miles per hour, when actual practical speeds were in the order of 15 miles per hour. This illustrated the point of working beyond the range of the original data. Limiting the Travel Time Ratio to the range actually found by Rhyason eliminated the glaring errors, although some of the widely scattered observations within the remaining range are undoubtedly open to question. Any further work in this area should also eliminate all cases where the observed mode split differs from the predicted by more than the standard error of estimate.

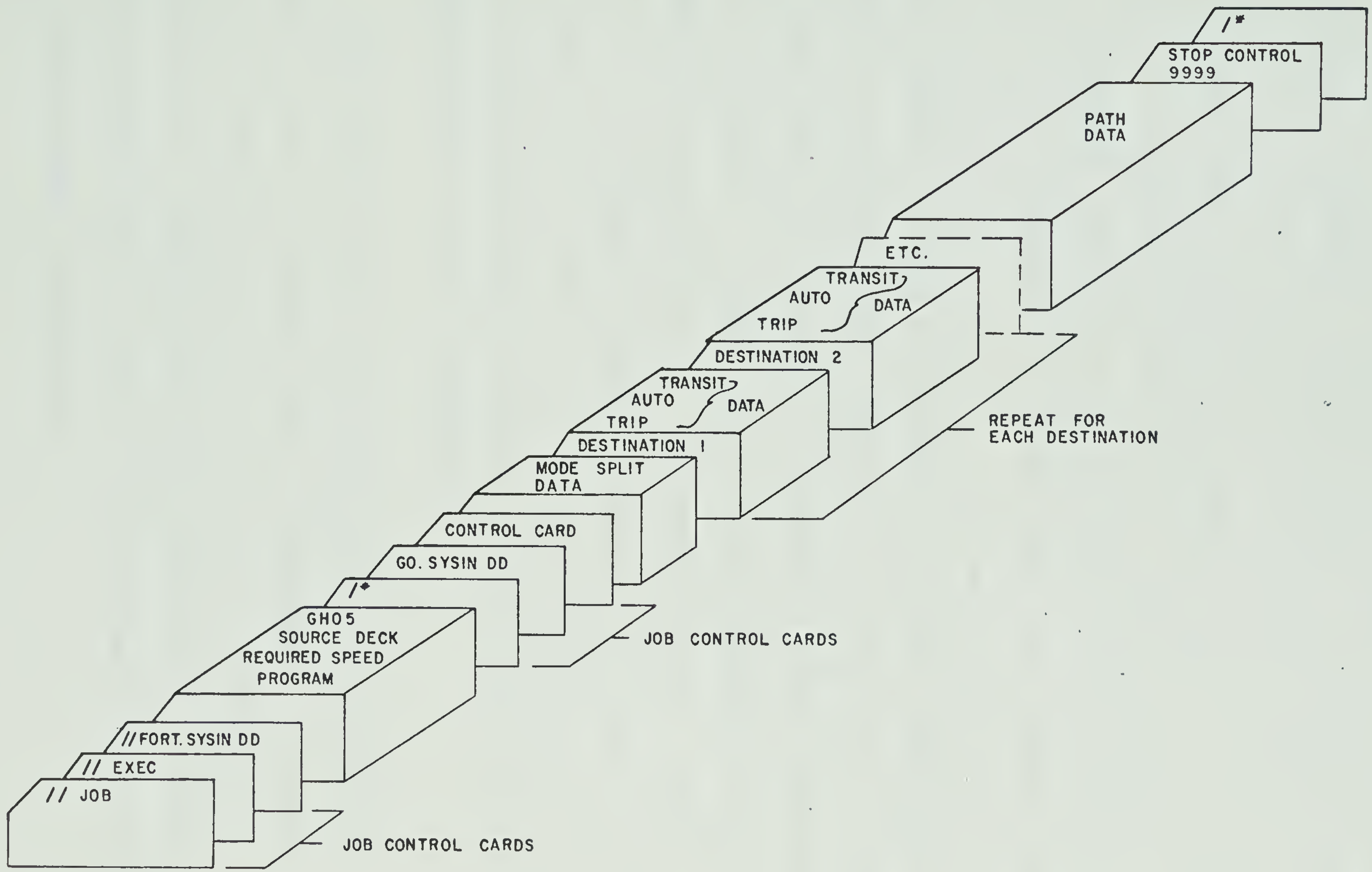


FIGURE 4·13 DECK COMPOSITION – REQUIRED SPEED PROGRAM NO. 5

There were several networks tested through the steps listed. The abortive run 0 identified problems with the tree building program. Run 1 was used to test the program and the basic 1964 network. (see FIGURE F.1) Run 2 was actually only a partial run used to test that transfers to be added and the bus links to be romoved in order to attract a reasonable ridership to the test rapid transit network. The test was considered reasonable if the new system had at least as many patrons as the bus lines it replaced. Run 3 was the main test of a proposed rapid transit facility superimposed on the basic 1964 Edmonton Transit network. The transit system considered was proposed by J. J. Bakker in his report "Public Transportation in Edmonton," 1968. This network is shown in FIGURE F.2. A rapid transit system recommended by the City Commissioners was also tried. This network was only detailed to the extent of information gleaned by hearing a description on T.V., and the analysis was cut short by the closing of the computing centre for moving, but the coded network is available, and the "trees" are on tape 1512. This network is shown in FIGURE F.3.

The running times on the rapid transit links tested were determined by means of a moving template incorporating the optimum acceleration, running speed, station stop time, and deceleration characteristics of a typical rapid transit installation. The operating characteristics used in this test were obtained from the Bechtel Report on Rapid Transit for Edmonton.

Headway = 5 minutes

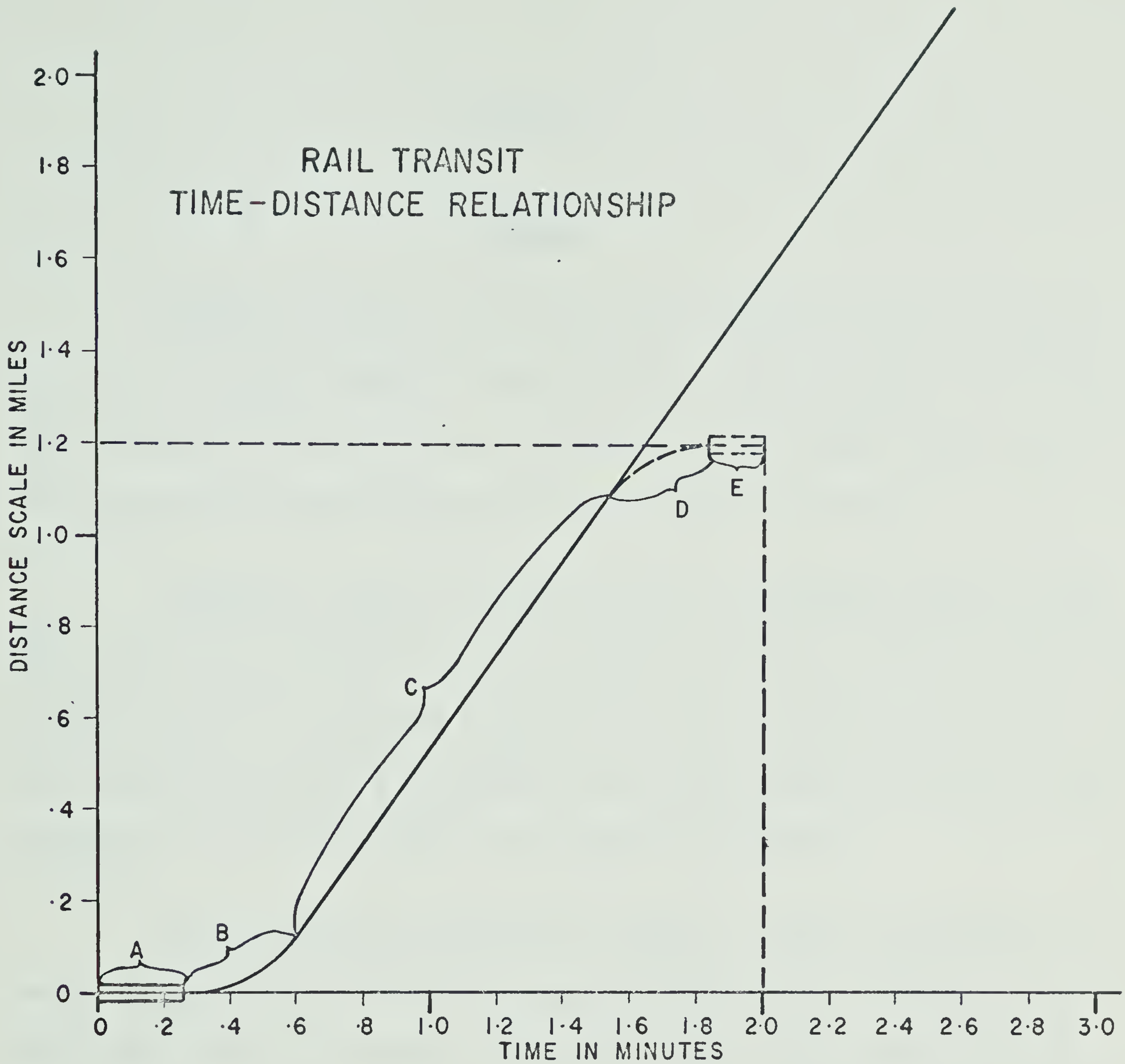
Acceleration = 2.5 miles per hour per second

Running Speed = 50 miles per hour

Deceleration = 2.5 miles per hour per second

Station dwell = 20 seconds

FIGURE IV.13 shows the composite template used to obtain average operating speed between rapid transit nodes. The horizontal line through the moveable portion of the template was placed on the scaled distance, and the average running time was read from the time scale.



SOLID LINES ARE ON FIXED PORTION
DOTTED LINES ARE ON SLIDING PORTION

A = 1/2 STATION DWELL = 10 SEC.
B = ACCELERATION = 2·5 MPHPS.
C = RUNNING SPEED = 50 MPH.
D = DECELERATION = 2·5 MPHPS.
E = 1/2 STATION DWELL = 10 SEC.

FIGURE 4·14 RAPID TRANSIT TIME-DISTANCE TEMPLATE

CHAPTER V

RESULTS

TABLE V.1 lists the results of the "Required Speed" analysis for run 1, the 1964 Edmonton Transit Network. This was the basic network that was used to test the various programs and the rapid transit test alternatives were superimposed theron for subsequent runs.

TABLE V.2 lists the links of Run 1 in ascending order of load. Since these trips include only A.M. peak hour trips to Central Study Area destinations, they cannot be compared to actual patronage at any spot, but the network was adjusted by adding or deleting transfers until the trips appeared to be in proportion to the observed ridership.

An interesting exception was found in links 552 and 553, by which any trips from northside origins to destination centroid 4, the Government Centre, would have to arrive. Since these links do not appear in TABLES V.1 and V.2, and yet Government Centre employees do arrive by transit, the omission was investigated. The omission was traced back to the internal workings of the "Required Speed" program, as described in Chapter IV, Item 6 and 7. A few of the trips were eliminated from consideration as "transit impossibles", but most were removed because they were "outliers". Further investigation revealed that the difficulty of attracting trips to the Government Centre had been recognized

by the Transit System, and there had been "special" peak hour service to the Government Centre in 1964, in an effort to attract trips from difficult areas. The Author had only included scheduled runs in the 1964 network. Since the special runs have been discontinued, and since the Rapid Transit Facility to the subsequently tested would not be affected by their inclusion, the specials were not added to the basic network.

TABLE V.3 lists the complete results of the "Required Speed" analysis for run 3, the 1964 Edmonton Transit network with a loop Rapid Transit System superimposed. A coding slip resulted in the mischievous suggestion appearing in the title of TABLE V.1, that this is the 1994 Transit Network. Subsequent announcements by the City of Edmonton encouraged the author to leave the mistake uncorrected, since it may be prophetic.

Run 3 contains many links unaffected by the inclusion of the rapid transit system, so is in part indicative of Run 1. It also contains nearly all of the components of the rapid transit system tried in Run 4, so is considered representative of the entire exercise.

It was interesting, and possibly even instructive, to the existing and required speeds of various specific links in relation to their physical situation. Starting at the top of TABLE V.1, links 3, 4, and 5 (see FIGURE F.2) are on 97 St. north of Jasper Avenue. In each case, the existing speed is sufficient to contribute to a mode

split comparable to the city average. Links 6 and 7 are on Jasper Avenue from 97 St. to 101 St. Their existing speeds are definitely contributing to a low mode split. Link 214 represents a poor coding job, since it includes a layover in Meadowlark Park Shopping Centre.

It is perhaps significant that many of the links whose existing speed is associated with low mode splits, are downtown links containing large, major bus stops.

The rapid transit links which it was desired to test begin at 608 to 641 on page 5 of TABLE V.1. Note that with the exception of links 640 and 641 the existing speed is adequate to attract a substantial mode split. This exception is an error in the procedure used to determine rapid transit link times. These links were on either side of a transfer node and erroneously contained the time for a station stop.

Although not particularly applicable to the fictitious network tested, TABLE V.4 contains a listing of network links in ascending order of load. The number of trips is not significant since they are 1964 downtown destined trips assigned to a network not expected to be supported by a city of that size or that narrow a trip purpose. The listing is included only because it would be valuable in a real analysis of alternatives and is logically included in this type of program. It was not intended to predict the ridership on this particular test network.

TABLE V.1

RESULTS OF REQUIRED SPEED ANALYSIS FOR RUN 1

RUN NO. 1 1964 TRANSIT NETWORK PAGE 1

LINK NO.	1964 SPEED	SPEED REQ'D TO ATTAIN VARIOUS MODE SPLITS 20%	30%	40%	50%	60%
3	9.9	6.1	7.1	8.3	9.7	11.8
4	10.0	6.1	7.1	8.3	9.7	11.8
5	9.0	6.1	7.1	8.3	9.7	11.8
6	6.6	7.3	8.3	9.8	12.4	16.7
7	7.1	10.4	12.1	14.4	18.0	24.0
11	13.0	6.0	6.8	7.4	8.3	10.3
12	12.3	6.0	6.8	7.4	8.3	10.3
13	12.0	6.0	6.8	7.4	8.3	10.3
14	6.6	7.1	8.2	9.6	11.9	15.5
18	14.7	6.4	7.4	8.7	10.6	13.7
21	11.4	7.1	8.2	9.6	11.9	16.1
24	9.7	5.3	6.1	7.1	9.4	14.8
25	7.2	5.3	6.1	7.1	9.4	14.8
26	7.1	10.8	12.3	14.1	17.9	25.8
27	6.4	10.8	12.3	14.1	17.9	25.8
31	15.0	3.8	4.4	5.2	6.4	8.4
32	7.0	3.8	4.4	5.2	6.4	8.4
33	7.6	3.8	4.4	5.2	6.4	8.4
34	7.4	3.8	4.4	5.2	6.4	8.4
37	10.2	5.3	6.1	7.1	9.4	14.8
38	10.2	5.3	6.1	7.1	9.4	14.8
41	10.8	5.1	6.0	7.1	8.9	12.1
42	10.2	5.1	6.0	7.1	8.9	12.1
45	13.0	10.8	12.3	14.1	17.9	25.8
46	18.4	10.8	12.3	14.1	17.9	25.8
51	15.7	5.2	5.7	6.2	6.9	8.5
53	12.6	9.3	10.8	12.7	15.8	20.7
54	18.0	9.3	10.8	12.7	15.8	20.7
55	17.8	9.3	10.8	12.7	15.8	20.7
56	7.6	9.3	10.8	12.7	15.8	20.7
60	11.2	5.8	6.5	7.2	8.8	11.7
61	4.9	5.8	6.5	7.2	8.8	11.7
63	4.9	5.8	6.5	7.2	8.8	11.7
64	4.7	5.8	6.5	7.2	8.8	11.7
65	5.3	5.8	6.5	7.2	8.8	11.7
66	5.3	5.8	6.5	7.2	8.8	11.7
73	11.5	5.8	6.5	7.2	8.8	11.7
76	12.0	5.8	6.5	7.2	8.8	11.7
77	13.2	5.8	6.5	7.2	8.8	11.7
80	12.0	5.8	6.5	7.2	8.8	11.7
83	11.0	6.4	7.4	8.7	10.6	13.7
84	14.6	6.4	7.4	8.7	10.6	13.7
88	10.7	6.4	7.4	8.7	10.6	13.7
89	10.6	6.4	7.4	8.7	10.6	13.7
92	10.8	6.4	7.4	8.7	10.6	13.7
95	7.0	6.0	6.8	7.4	8.3	10.3
96	12.9	6.0	6.8	7.4	8.3	10.3
98	10.3	6.1	7.1	8.3	9.7	11.8
101	9.4	6.1	7.1	8.3	9.7	11.8
102	6.9	6.1	7.1	8.3	9.7	11.8
103	12.0	6.1	7.1	8.3	9.7	11.8
104	6.7	6.0	6.8	7.4	8.3	10.3

TABLE V.1 (Continued)

RUN NO. 1 1964 TRANSIT NETWORK PAGE 2

LINK NO.	1964 SPEED	SPEED REQ'D TO ATTAIN VARIOUS MODE SPLITS 20%	30%	40%	50%	60%
108	12.6	7.1	8.3	9.8	12.4	16.7
109	12.0	7.1	8.3	9.8	12.4	16.7
110	12.4	7.1	8.3	9.8	12.4	16.7
111	8.6	7.1	8.3	9.8	12.4	16.7
113	11.8	7.1	8.3	9.8	12.4	16.7
114	11.8	7.3	8.3	9.8	12.4	16.7
117	9.8	6.4	7.5	8.9	10.4	12.9
118	11.3	6.4	7.5	8.9	10.4	12.9
121	17.4	6.0	6.8	7.4	8.3	10.3
124	13.9	5.9	6.9	8.0	9.3	11.3
125	13.5	10.6	11.8	13.3	16.3	21.8
126	9.4	6.0	6.8	7.4	8.3	10.3
129	10.3	7.4	8.3	9.8	11.5	14.5
130	10.5	7.4	8.3	9.8	11.5	14.5
132	12.5	7.4	8.3	9.8	11.5	14.5
135	11.0	5.8	6.5	7.2	8.8	11.7
136	10.8	5.8	6.5	7.2	8.8	11.7
141	15.7	10.8	12.7	15.2	19.3	26.4
142	10.7	10.8	12.7	15.2	19.3	26.4
143	10.5	12.4	13.7	15.5	19.6	28.2
144	9.3	12.4	13.7	15.5	19.6	28.2
145	10.0	12.4	13.7	15.5	19.6	28.2
146	8.0	12.4	13.7	15.5	19.6	28.2
150	12.0	10.0	11.3	12.8	15.7	21.5
151	12.3	10.0	11.3	12.8	15.7	21.5
152	12.7	10.8	12.7	15.2	19.3	26.4
153	13.0	10.8	12.7	15.2	19.3	26.4
154	13.0	10.8	12.7	15.2	19.3	26.4
155	12.0	10.8	12.7	15.2	19.3	26.4
156	12.6	10.8	12.7	15.2	19.3	26.4
157	13.8	10.8	12.7	15.2	19.3	26.4
158	13.3	10.8	12.7	15.2	19.3	26.4
159	15.3	10.8	12.7	15.2	19.3	26.4
160	15.7	10.8	12.7	15.2	19.3	26.4
161	15.0	10.8	12.7	15.2	19.3	26.4
171	12.6	10.8	12.3	14.1	17.9	25.8
172	12.7	10.8	12.3	14.1	17.9	25.8
173	12.6	10.8	12.3	14.1	17.9	25.8
176	12.5	10.8	12.3	14.1	17.9	25.8
177	13.0	10.8	12.3	14.1	17.9	25.8
178	13.7	10.8	12.3	14.1	17.9	25.8
179	13.3	10.8	12.3	14.1	17.9	25.8
182	15.6	10.8	12.3	14.1	17.9	25.8
183	13.0	10.8	12.3	14.1	17.9	25.8
184	13.1	10.8	12.3	14.1	17.9	25.8
187	11.3	12.4	13.7	15.5	19.6	28.2
188	10.7	12.4	13.7	15.5	19.6	28.2
189	12.0	12.4	13.7	15.5	19.6	28.2
190	10.7	12.4	13.7	15.5	19.6	28.2
194	11.3	5.8	6.5	7.2	8.8	11.7
197	11.7	10.6	11.8	13.3	16.3	21.8
198	12.2	10.6	11.8	13.3	16.3	21.8

TABLE V.1 (Continued)

RUN NO. 1 1964 TRANSIT NETWORK PAGE 3

LINK NO.	1964 SPEED	SPEED REQ D TO ATTAIN VARIOUS MODE SPLITS 20%	30%	40%	50%	60%
201	11.5	10.6	11.8	13.3	16.3	21.8
210	17.2	12.1	13.6	15.5	19.6	28.2
211	16.5	12.1	13.6	15.5	19.6	28.2
212	17.6	12.1	13.6	15.5	19.6	28.2
213	16.8	12.1	13.6	15.5	19.6	28.2
214	5.2	12.1	13.6	15.5	19.6	28.2
215	17.0	12.4	13.7	15.5	19.6	28.2
216	16.3	12.4	13.7	15.5	19.6	28.2
217	16.8	12.4	13.7	15.5	19.6	28.2
218	15.0	12.4	13.7	15.5	19.6	28.2
219	16.2	12.4	13.7	15.5	19.6	28.2
220	17.3	12.4	13.7	15.5	19.6	28.2
223	10.4	6.2	7.0	7.6	8.5	10.7
224	10.4	12.4	13.7	15.5	19.6	28.2
225	10.0	12.4	13.7	15.5	19.6	28.2
226	10.2	12.4	13.7	15.5	19.6	28.2
237	15.5	12.4	13.7	15.5	18.8	25.0
241	15.2	6.2	7.0	7.6	8.5	10.7
246	17.3	12.1	13.5	14.8	16.6	20.8
251	8.4	12.1	13.5	14.8	16.6	20.8
252	16.5	12.1	13.5	14.8	16.6	20.8
255	14.2	9.8	11.1	12.5	15.4	21.1
256	14.0	9.8	11.1	12.5	15.4	21.1
257	14.8	9.8	11.1	12.5	15.4	21.1
258	14.0	9.8	11.1	12.5	15.4	21.1
259	13.9	9.8	11.1	12.5	15.4	21.1
260	11.5	9.8	11.1	12.5	15.4	21.1
273	13.0	6.8	7.7	8.6	10.5	14.0
274	10.0	7.4	8.3	9.3	11.4	15.1
275	10.3	7.4	8.3	9.3	11.4	15.1
278	13.2	7.4	8.3	9.3	11.4	15.1
279	13.3	7.4	8.3	9.3	11.4	15.1
282	10.3	7.7	8.6	9.7	11.7	15.5
283	10.4	7.7	8.6	9.7	11.7	15.5
284	10.6	7.7	8.6	9.7	11.7	15.5
285	10.0	7.7	8.6	9.7	11.7	15.5
286	10.5	9.3	10.8	12.7	15.8	20.7
287	12.4	9.3	10.8	12.7	15.8	20.7
288	12.4	9.3	10.8	12.7	15.8	20.7
295	17.1	9.3	10.8	12.7	15.8	20.7
296	16.6	9.3	10.8	12.7	15.8	20.7
297	15.8	9.3	10.8	12.7	15.8	20.7
298	15.8	9.3	10.8	12.7	15.8	20.7
301	12.6	5.0	5.6	6.4	8.0	11.1
302	14.0	5.0	5.6	6.4	8.0	11.1
303	12.0	5.0	5.6	6.4	8.0	11.1
305	13.0	7.1	8.1	9.3	11.7	16.6
306	12.9	7.1	8.1	9.3	11.7	16.6
309	18.0	7.1	8.1	9.3	11.7	16.6
310	18.0	7.1	8.1	9.3	11.7	16.6
314	11.6	6.0	6.8	7.4	8.3	10.3
315	10.6	6.0	6.8	7.4	8.3	10.3

TABLE V.1 (Continued)

RUN NO. 1 1964 TRANSIT NETWORK PAGE 4

LINK NO.	1964 SPEED	SPEED REQ'D TO ATTAIN VARIOUS MODE SPLITS 20%	30%	40%	50%	60%
316	10.6	6.4	7.5	8.9	10.4	12.9
317	10.9	6.4	7.5	8.9	10.4	12.9
318	9.0	6.4	7.5	8.9	10.4	12.9
324	11.6	7.3	8.3	9.4	11.7	16.2
331	11.7	7.3	8.3	9.4	11.7	16.2
332	22.7	7.3	8.3	9.4	11.7	16.2
336	9.9	6.4	7.2	8.0	9.6	12.6
344	4.0	7.3	8.3	9.4	11.7	16.2
352	6.9	6.9	8.2	9.8	11.5	14.5
353	6.9	6.9	8.2	9.8	11.5	14.5
354	7.0	6.9	8.2	9.8	11.5	14.5
355	7.0	6.9	8.2	9.8	11.5	14.5
361	8.6	9.8	11.2	13.0	15.8	20.0
363	7.4	9.8	11.2	13.0	15.8	20.0
364	8.4	9.8	11.2	13.0	15.8	20.0
365	12.7	9.8	11.2	13.0	15.8	20.0
366	11.5	9.8	11.2	13.0	15.8	20.0
368	11.4	9.8	11.2	13.0	15.8	20.0
370	9.8	9.8	11.2	13.0	15.8	20.0
373	9.8	4.6	5.4	6.3	7.9	10.4
376	13.5	6.3	7.1	8.0	9.7	13.0
377	10.4	7.7	9.0	10.6	13.0	17.1
378	13.6	10.4	12.1	14.4	18.0	24.0
386	10.2	10.4	12.1	14.4	18.0	24.0
389	11.4	7.7	9.0	10.6	13.0	17.1
390	11.3	7.7	9.0	10.6	13.0	17.1
391	10.8	7.7	9.0	10.6	13.0	17.1
394	10.9	7.7	9.0	10.6	13.0	17.1
412	12.7	7.6	8.6	9.7	11.8	15.5
413	15.4	7.8	8.6	9.7	11.8	15.5
414	10.8	7.8	8.6	9.7	11.8	15.5
415	5.7	9.1	10.0	11.2	13.3	17.0
433	10.1	9.8	11.2	13.0	15.8	20.0
434	9.0	9.8	11.2	13.0	15.8	20.0
437	10.8	5.9	6.7	7.6	9.4	13.0
438	11.5	9.1	10.0	11.2	13.3	17.0
442	10.2	9.8	11.2	13.0	15.8	20.0
443	10.4	9.8	11.2	13.0	15.8	20.0
448	10.2	9.8	11.2	13.0	15.8	20.0
449	10.8	9.8	11.2	13.0	15.8	20.0
450	10.2	9.8	11.2	13.0	15.8	20.0
451	10.5	9.8	11.2	13.0	15.8	20.0
454	12.0	9.1	10.0	11.2	13.3	17.0
461	8.1	6.3	7.1	8.0	9.7	13.0
462	12.9	6.3	7.1	8.0	9.7	13.0
465	12.7	7.7	9.0	10.6	13.0	17.1
466	10.3	7.7	9.0	10.6	13.0	17.1
467	10.4	7.7	9.0	10.6	13.0	17.1
470	15.0	6.0	6.7	7.6	9.4	12.7
471	12.0	6.0	6.7	7.6	9.4	12.7
474	10.0	7.7	9.0	10.6	13.0	17.1
475	12.7	7.7	9.0	10.6	13.0	17.1

TABLE V.1 (Continued)

RUN NC. 1 1964 TRANSIT NETWORK PAGE 5

LINK NC.	1964 SPEED	SPEED REQ D TO ATTAIN VARIOUS MODE SPLITS 20%	30%	40%	50%	60%
476	13.1	7.7	9.0	10.6	13.0	17.1
477	12.7	7.7	9.0	10.6	13.0	17.1
480	8.1	6.3	7.1	8.0	9.7	13.0
481	8.0	6.3	7.1	8.0	9.7	13.0
482	8.1	6.3	7.1	8.0	9.7	13.0
483	8.3	6.3	7.1	8.0	9.7	13.0
484	8.1	6.3	7.1	8.0	9.7	13.0
485	8.1	6.3	7.1	8.0	9.7	13.0
492	9.4	5.3	6.0	6.8	8.4	11.6
495	10.5	10.4	12.1	14.4	18.0	24.0
498	9.2	5.3	6.0	6.8	8.4	11.6
499	9.0	5.3	6.0	6.8	8.4	11.6
502	9.6	5.3	6.0	6.8	8.4	11.6
503	9.0	5.3	6.0	6.8	8.4	11.6
507	9.9	6.6	7.5	8.7	11.0	16.1
508	10.3	7.1	8.2	9.6	11.9	16.1
513	13.7	7.1	8.2	9.6	11.9	15.5
514	13.4	7.1	8.2	9.6	11.9	15.5
515	12.7	7.1	8.2	9.6	11.9	15.5
516	13.4	7.1	8.2	9.6	11.9	15.5
517	13.3	7.1	8.2	9.6	11.9	15.5
520	13.4	10.4	12.1	14.4	18.0	24.0
521	12.0	10.4	12.1	14.4	18.0	24.0
522	12.0	10.4	12.1	14.4	18.0	24.0
523	13.1	10.4	12.1	14.4	18.0	24.0
524	13.4	10.4	12.1	14.4	18.0	24.0
525	13.1	10.4	12.1	14.4	18.0	24.0
526	13.8	10.4	12.1	14.4	18.0	24.0
529	11.5	6.9	8.1	9.7	12.2	16.6
530	11.1	6.9	8.1	9.7	12.2	16.6
533	10.9	6.9	8.1	9.7	12.2	16.6
534	11.2	6.9	8.1	9.7	12.2	16.6
546	11.6	9.1	10.0	11.2	13.3	17.0
547	11.7	9.1	10.0	11.2	13.3	17.0
548	11.4	9.1	10.0	11.2	13.3	17.0
575	10.7	5.8	6.5	7.2	8.8	11.7
576	10.8	5.8	6.5	7.2	8.8	11.7
593	12.3	9.1	10.0	11.2	13.3	17.0

TABLE V.2

RUN 1 LINKS IN ASCENDING ORDER OF LOAD

LINKS IN ASCENDING ORDER OF LOAD PAGE 1

LINK	TRIPS	LINK LENGTH	EXISTING TIME	EXISTING SPEED
223	6	0.26	1.5	10.4
241	6	0.33	1.3	15.2
251	8	0.14	1.0	8.4
252	8	0.33	1.2	16.5
546	13	0.31	1.6	11.6
547	13	0.47	2.4	11.7
548	13	0.19	1.0	11.4
448	18	0.34	2.0	10.2
449	18	0.27	1.5	10.8
450	18	0.34	2.0	10.2
451	18	0.70	4.0	10.5
41	30	0.09	0.5	10.8
42	30	0.22	1.3	10.2
255	36	0.95	4.0	14.2
480	38	0.27	2.0	8.1
481	38	0.36	2.7	8.0
301	56	0.40	1.9	12.6
302	56	0.07	0.3	14.0
303	56	0.16	0.8	12.0
246	57	0.72	2.5	17.3
454	57	0.52	2.6	12.0
412	59	0.34	1.6	12.8
413	59	0.36	1.4	15.4
256	62	0.35	1.5	14.0
257	62	0.32	1.3	14.8
258	62	0.28	1.2	14.0
470	73	0.30	1.2	15.0
471	73	0.30	1.5	12.0
373	77	0.18	1.1	9.8
305	81	0.26	1.2	13.0
306	81	0.43	2.0	12.9
309	81	0.33	1.1	18.0
310	81	0.33	1.1	18.0
513	83	0.41	1.8	13.7
514	83	0.49	2.2	13.4
515	83	0.19	0.9	12.7
516	83	0.38	1.7	13.4
517	83	0.31	1.4	13.3
502	87	0.32	2.0	9.6
503	87	0.18	1.2	9.0
437	88	0.18	1.0	10.8
117	90	0.31	1.9	9.8
118	90	0.47	2.5	11.3
316	90	0.23	1.3	10.6
317	90	0.20	1.1	10.9
318	90	0.06	0.4	9.0
507	92	0.33	2.0	9.9
150	94	0.20	1.0	12.0
210	95	0.43	1.5	17.2
211	95	0.11	0.4	16.5
212	95	0.44	1.5	17.6
474	96	0.45	2.7	10.0
475	96	0.19	0.9	12.7
476	96	0.48	2.2	13.1

TABLE V.2 (Continued)

LINKS IN ASCENDING ORDER OF LOAD PAGE 2

LINK	TRIPS	LINK LENGTH	EXISTING TIME	EXISTING SPEED
478	96	0.48	2.2	13.1
477	96	0.19	0.9	12.7
125	97	0.27	1.2	13.5
201	97	1.00	5.2	11.5
151	106	0.37	1.8	12.3
259	107	0.56	2.5	13.[illegible]
260	107	3.40	17.7	11.5
31	109	0.25	1.0	15.0
32	109	0.14	1.2	7.0
33	109	0.14	1.1	7.6
34	109	0.21	1.7	7.4
182	109	0.26	1.0	15.6
183	109	0.13	0.6	13.0
184	109	0.35	1.6	13.1
282	116	0.62	3.6	10.3
336	123	0.53	3.2	9.9
331	127	0.68	3.5	11.7
533	130	0.31	1.7	10.9
534	130	0.30	1.6	11.2
213	134	0.28	1.0	16.8
214	134	0.25	2.9	5.2
215	134	0.51	1.8	17.0
216	134	0.38	1.4	16.3
51	135	0.21	0.8	15.7
104	137	0.10	0.9	6.7
121	137	0.29	1.0	17.4
126	137	0.78	5.0	9.4
314	137	0.31	1.6	11.6
315	137	0.39	2.2	10.6
482	140	0.38	2.8	8.1
438	145	0.25	1.3	11.5
593	145	0.43	2.1	12.3
198	157	2.84	14.0	12.2
152	161	0.34	1.6	12.8
92	164	0.56	3.1	10.8
108	167	0.42	2.0	12.6
109	167	0.10	0.5	12.0
110	167	0.31	1.5	12.4
111	167	0.10	0.7	8.6
124	169	0.51	2.2	13.9
278	171	0.55	2.5	13.2
279	171	0.42	1.9	13.3
442	171	0.56	3.3	10.2
443	171	0.26	1.5	10.4
414	173	0.18	1.0	10.8
520	176	0.49	2.2	13.4
521	176	0.10	0.5	12.0
522	176	0.10	0.5	12.0
523	176	0.70	3.2	13.1
524	176	0.56	2.5	13.4
525	176	0.24	1.1	13.1
526	176	0.23	1.0	13.8
153	179	0.26	1.2	13.0
154	179	0.26	1.2	13.0

TABLE V.2 (Continued)

LINKS IN ASCENDING ORDER OF LOAD PAGE 3

LINK	TRIPS	LINK LENGTH	EXISTING TIME	EXISTING SPEED
154	179	0.26	1.2	13.0
155	179	0.18	0.9	12.0
156	179	0.21	1.0	12.6
157	179	0.23	1.0	13.8
158	179	0.31	1.4	13.3
159	179	0.23	0.9	15.3
160	179	0.21	0.8	15.7
161	179	0.35	1.4	15.0
217	182	0.73	2.6	16.8
218	182	0.10	0.4	15.0
219	182	0.27	1.0	16.2
220	182	0.26	0.9	17.3
295	184	0.20	0.7	17.1
296	184	0.36	1.3	16.6
297	184	0.50	1.9	15.8
298	184	0.66	2.5	15.8
226	194	0.41	2.4	10.2
37	197	0.29	1.7	10.2
38	197	0.29	1.7	10.2
273	199	0.54	2.5	13.0
197	202	0.35	1.8	11.7
465	206	0.19	0.9	12.7
224	208	0.26	1.5	10.4
225	208	0.10	0.6	10.0
529	216	0.21	1.1	11.5
530	216	0.24	1.3	11.1
187	229	1.24	6.6	11.3
188	229	0.59	3.3	10.7
189	229	0.16	0.8	12.0
190	229	0.48	2.7	10.7
324	231	0.31	1.6	11.6
344	231	0.06	0.9	4.0
176	234	0.25	1.2	12.5
177	234	0.67	3.1	13.0
178	234	0.16	0.7	13.7
179	234	0.20	0.9	13.3
433	243	0.37	2.2	10.1
434	243	0.24	1.6	9.0
98	247	0.43	2.5	10.3
101	247	0.66	4.2	9.4
102	247	0.37	3.2	6.9
103	247	0.20	1.0	12.0
135	249	0.42	2.3	11.0
136	249	0.52	2.9	10.8
575	249	0.25	1.4	10.7
576	249	0.27	1.5	10.8
498	259	0.26	1.7	9.2
499	259	0.18	1.2	9.0
483	265	0.25	1.8	8.3
484	265	0.38	2.8	8.1
485	265	0.19	1.4	8.1
283	278	0.47	2.7	10.4
284	278	0.30	1.7	10.6
466	279	0.12	0.7	10.3

TABLE V.2 (Continued)

LINKS IN ASCENDING ORDER CF LCAO PAGE 4

LINK	TRIPS	LINK LENGTH	EXISTING TIME	EXISTING SPEED
466	279	0.12	0.7	10.3
467	279	C.19	1.1	10.4
88	292	C.16	0.9	10.7
89	292	0.55	3.1	10.6
508	307	1.20	7.0	10.3
113	313	C.61	3.1	11.8
361	314	C.33	2.3	8.6
415	318	C.38	4.0	5.7
194	332	C.17	0.9	11.3
492	333	C.36	2.3	9.4
171	346	C.40	1.9	12.6
172	346	C.17	0.8	12.7
173	346	0.40	1.9	12.6
394	349	0.60	3.3	10.9
3	353	C.58	3.5	9.9
4	353	C.20	1.2	10.C
5	353	C.12	0.8	9.0
332	354	1.93	5.1	22.7
274	37C	0.30	1.8	10.0
275	37C	C.43	2.5	10.3
461	381	C.19	1.4	8.1
462	381	C.28	1.3	12.9
285	382	C.20	1.2	10.0
83	384	C.22	1.2	11.0
84	384	C.95	3.9	14.6
45	398	0.50	2.3	13.0
46	398	1.23	4.0	18.4
141	398	C.21	0.8	15.7
142	398	1.50	8.4	10.7
24	420	C.29	1.8	9.7
129	452	C.43	2.5	10.3
130	452	0.21	1.2	10.5
132	452	2.50	12.0	12.5
144	453	C.14	C.9	9.3
95	466	0.27	2.3	7.C
96	466	0.30	1.4	12.9
495	476	0.93	5.3	10.5
21	479	C.19	1.0	11.4
80	479	0.28	1.4	12.0
18	5C0	0.27	1.1	14.7
389	524	C.19	1.0	11.4
39C	524	0.17	C.9	11.3
25	529	C.36	3.0	7.2
386	530	0.46	2.7	10.2
145	534	C.15	0.9	10.0
146	534	0.08	0.6	8.0
286	566	0.21	1.2	10.5
287	566	0.31	1.5	12.4
288	566	0.31	1.5	12.4
365	566	C.72	3.4	12.7
366	566	0.21	1.1	11.5
368	566	C.19	1.0	11.4
370	566	0.41	2.5	9.8
76	62C	0.22	1.1	12.C

TABLE V.2 (Continued)

LINKS IN ASCENDING ORDER OF LOAD PAGE 5

LINK	TRIPS	LINK LENGTH	EXISTING TIME	EXISTING SPEED
76	620	0.22	1.1	12.0
77	620	0.11	0.5	13.2
143	627	0.21	1.2	10.5
363	632	0.31	2.5	7.4
376	665	0.81	3.6	13.5
114	667	1.55	7.9	11.8
63	704	0.14	1.7	4.9
64	704	0.14	1.8	4.7
65	704	0.08	0.9	5.3
66	704	0.08	0.9	5.3
364	709	0.07	0.5	8.4
11	800	0.13	0.6	13.0
12	800	0.43	2.1	12.3
13	800	0.18	0.9	12.0
61	854	0.14	1.7	4.9
391	857	0.47	2.6	10.8
73	861	0.25	1.3	11.5
53	870	0.42	2.0	12.6
54	870	0.75	2.5	18.0
55	870	1.01	3.4	17.8
56	870	0.52	4.1	7.6
60	1007	0.15	0.8	11.2
352	1444	0.08	0.7	6.9
353	1444	0.08	0.7	6.9
354	1444	0.14	1.2	7.0
355	1444	0.14	1.2	7.0
377	1522	0.19	1.1	10.4
26	1536	0.19	1.6	7.1
27	1536	0.15	1.4	6.4
14	1779	0.33	3.0	6.6
378	2052	0.68	3.0	13.6
6	2799	0.21	1.9	6.6
7	4851	0.13	1.1	7.1

TABLE V.3

RESULTS OF REQUIRED SPEED ANALYSIS FOR RUN 3

RUN NO. 3 1994 TRANSIT NETWORK PAGE 1

LINK NO.	1994 SPEED	SPEED REQ'D TO ATTAIN VARIOUS MODE SPLITS 20%	30%	40%	50%	60%
3	9.9	3.8	4.3	4.8	5.9	8.0
4	10.0	3.8	4.3	4.8	5.9	8.0
5	9.0	3.8	4.3	4.8	5.9	8.0
6	6.6	7.1	8.2	9.6	11.9	15.5
7	7.1	10.4	12.1	14.4	18.0	24.0
11	13.0	6.6	7.8	9.2	10.8	13.4
12	12.3	6.6	7.8	9.2	10.8	13.4
13	12.0	6.6	7.8	9.2	10.8	13.4
14	6.6	7.1	8.2	9.6	11.9	15.5
18	14.7	6.4	7.4	8.7	10.6	13.7
21	11.4	7.1	8.2	9.6	11.9	16.1
24	9.7	5.3	6.1	7.1	9.4	14.8
25	7.2	5.3	6.1	7.1	9.4	14.8
26	7.1	10.6	11.8	13.3	16.3	21.8
27	6.4	10.6	11.8	13.3	16.3	21.8
31	15.0	3.8	4.4	5.2	6.4	8.4
32	7.0	3.8	4.4	5.2	6.4	8.4
33	7.6	3.8	4.4	5.2	6.4	8.4
34	7.4	3.8	4.4	5.2	6.4	8.4
37	10.2	5.3	6.1	7.1	9.4	14.8
38	10.2	5.3	6.1	7.1	9.4	14.8
41	10.8	5.1	6.0	7.1	8.9	12.1
42	10.2	5.1	6.0	7.1	8.9	12.1
45	13.0	5.1	6.0	7.2	9.1	12.4
46	18.4	5.1	6.0	7.2	9.1	12.4
51	15.7	5.2	5.7	6.2	6.9	8.5
53	12.6	9.3	10.8	12.7	15.8	20.7
54	18.0	9.3	10.8	12.7	15.8	20.7
55	17.8	9.3	10.8	12.7	15.8	20.7
56	7.6	9.3	10.8	12.7	15.8	20.7
60	11.2	4.2	4.6	5.2	6.1	7.6
61	4.9	4.2	4.6	5.2	6.1	7.6
63	4.9	4.2	4.6	5.2	6.1	7.6
64	4.7	4.2	4.6	5.2	6.1	7.6
65	5.3	4.2	4.6	5.2	6.1	7.6
66	5.3	4.2	4.6	5.2	6.1	7.6
73	11.5	4.2	4.6	5.2	6.1	7.6
76	12.0	4.2	4.6	5.2	6.1	7.6
77	13.2	4.2	4.6	5.2	6.1	7.6
80	12.0	4.1	4.5	4.9	5.8	7.2
83	11.0	6.4	7.4	8.7	10.6	13.7
84	14.6	6.4	7.4	8.7	10.6	13.7
88	10.7	6.4	7.4	8.7	10.6	13.7
89	10.6	6.4	7.4	8.7	10.6	13.7
92	10.8	6.4	7.4	8.7	10.6	13.7
95	7.0	6.6	7.8	9.2	10.8	13.4
96	12.0	6.6	7.8	9.2	10.8	13.4
104	6.7	6.6	7.8	9.2	10.8	13.4
108	12.6	9.1	10.7	12.7	16.0	21.5
109	12.0	9.1	10.7	12.7	16.0	21.5
110	12.4	9.1	10.7	12.7	16.0	21.5
117	9.8	6.6	7.8	9.2	10.8	13.4

TABLE V.3 (Continued)

RUN NO. 3 1974 TRANSIT NETWORK PAGE 2

LINK NO.	1974 SPEED	SPEED NEEDED TO ATTAIN VARIOUS MODE SPLITS 20%	30%	40%	50%	60%
118	11.3	6.6	7.8	9.2	10.8	13.4
120	9.4	6.6	7.8	9.2	10.8	13.4
121	17.4	6.6	7.8	9.2	10.8	13.4
124	13.9	5.0	6.9	8.0	9.3	11.3
125	13.5	10.6	11.8	13.3	16.3	21.8
135	11.0	5.0	5.6	6.3	7.6	10.1
136	10.8	5.0	5.6	6.3	7.6	10.1
137	10.2	5.0	5.6	6.3	7.6	10.1
141	15.7	10.8	12.7	15.2	19.3	26.4
142	10.7	10.8	12.7	15.2	19.3	26.4
143	10.5	12.4	13.7	15.5	19.6	28.2
144	9.3	12.4	13.7	15.5	19.6	28.2
145	10.0	12.4	13.7	15.5	19.6	28.2
146	8.0	12.4	13.7	15.5	19.6	28.2
150	12.0	10.0	11.3	12.8	15.7	21.5
151	12.3	10.0	11.3	12.8	15.7	21.5
152	12.7	10.8	12.7	15.2	19.3	26.4
153	13.0	10.8	12.7	15.2	19.3	26.4
154	13.0	10.8	12.7	15.2	19.3	26.4
155	12.0	10.8	12.7	15.2	19.3	26.4
156	12.6	10.8	12.7	15.2	19.3	26.4
157	13.8	10.8	12.7	15.2	19.3	26.4
158	13.3	10.8	12.7	15.2	19.3	26.4
159	15.3	10.8	12.7	15.2	19.3	26.4
160	15.7	10.8	12.7	15.2	19.3	26.4
161	15.0	10.8	12.7	15.2	19.3	26.4
168	12.0	9.1	10.7	12.7	16.0	21.5
171	12.6	10.1	11.5	13.2	16.7	24.2
172	12.7	10.1	11.5	13.2	16.7	24.2
176	12.5	10.1	11.5	13.2	16.7	24.2
177	13.0	10.1	11.5	13.2	16.7	24.2
178	13.7	10.1	11.5	13.2	16.7	24.2
179	13.3	10.1	11.5	13.2	16.7	24.2
182	15.6	10.1	11.5	13.2	16.7	24.2
183	13.0	10.1	11.5	13.2	16.7	24.2
184	13.1	10.1	11.5	13.2	16.7	24.2
187	11.3	12.4	13.7	15.5	19.6	28.2
188	10.7	12.4	13.7	15.5	19.6	28.2
189	12.0	12.4	13.7	15.5	19.6	28.2
190	10.7	12.4	13.7	15.5	19.6	28.2
197	11.7	10.6	11.8	13.3	16.3	21.8
198	12.2	10.6	11.8	13.3	16.3	21.8
201	11.5	10.6	11.8	13.3	16.3	21.8
206	9.0	9.1	10.7	12.7	16.0	21.5
210	17.2	12.1	13.6	15.5	19.6	28.2
211	16.5	12.1	13.6	15.5	19.6	28.2
212	17.6	12.1	13.6	15.5	19.6	28.2
213	16.8	12.1	13.6	15.5	19.6	28.2
214	5.2	12.1	13.6	15.5	19.6	28.2
215	17.0	12.4	13.7	15.5	19.6	28.2
216	16.3	12.4	13.7	15.5	19.6	28.2
217	16.8	12.4	13.7	15.5	19.6	28.2

TABLE V.3 (Continued)

RUN NO. 3 1994 TRANSIT NETWORK PAGE 3

LINK NO.	1994 SPEED	SPEED REQ'D TO ATTAIN VARIOUS MODE SPLITS 20%	30%	40%	50%	60%
218	15.0	12.4	13.7	15.5	19.6	28.2
219	16.2	12.4	13.7	15.5	19.6	28.2
220	17.3	12.4	13.7	15.5	19.6	28.2
223	10.4	6.2	7.0	7.6	8.5	10.7
224	10.4	12.4	13.7	15.5	19.6	28.2
225	10.0	12.4	13.7	15.5	19.6	28.2
226	10.2	12.4	13.7	15.5	19.6	28.2
237	15.5	12.4	13.7	15.5	18.8	25.0
241	15.2	6.2	7.0	7.6	8.5	10.7
245	17.3	12.1	13.5	14.8	16.6	20.8
251	8.4	12.1	13.5	14.8	16.6	20.8
252	16.5	12.1	13.5	14.8	16.6	20.8
255	14.2	9.8	11.1	12.5	15.4	21.1
256	14.0	9.8	11.1	12.5	15.4	21.1
257	14.8	9.8	11.1	12.5	15.4	21.1
258	14.0	9.8	11.1	12.5	15.4	21.1
259	13.9	9.8	11.1	12.5	15.4	21.1
260	11.5	9.8	11.1	12.5	15.4	21.1
273	13.0	7.0	7.9	8.9	10.8	14.5
274	10.0	7.6	8.6	9.6	11.7	15.6
278	13.2	7.6	8.6	9.6	11.7	15.6
279	13.3	7.6	8.6	9.6	11.7	15.6
282	10.3	7.7	8.6	9.7	11.7	15.5
283	10.4	7.7	8.6	9.7	11.7	15.5
284	10.6	7.7	8.6	9.7	11.7	15.5
285	10.0	7.7	8.6	9.7	11.7	15.5
286	10.5	9.3	10.8	12.7	15.8	20.7
287	12.4	9.3	10.8	12.7	15.8	20.7
288	12.4	9.3	10.8	12.7	15.8	20.7
295	17.1	9.3	10.8	12.7	15.8	20.7
296	16.6	9.3	10.8	12.7	15.8	20.7
297	15.8	9.3	10.8	12.7	15.8	20.7
298	15.8	9.3	10.8	12.7	15.8	20.7
301	12.6	6.5	7.3	8.3	10.4	14.4
302	14.0	6.5	7.3	8.3	10.4	14.4
303	12.0	6.5	7.3	8.3	10.4	14.4
305	13.0	8.6	9.8	11.2	14.1	20.1
306	12.9	8.6	9.8	11.2	14.1	20.1
309	18.0	8.6	9.8	11.2	14.1	20.1
310	18.0	8.6	9.8	11.2	14.1	20.1
314	11.6	7.3	8.1	8.9	9.9	12.4
315	10.6	7.3	8.1	8.9	9.9	12.4
316	10.6	7.3	8.1	8.9	9.9	12.4
317	10.9	7.3	8.1	8.9	9.9	12.4
318	9.0	7.3	8.1	8.9	9.9	12.4
324	11.6	9.1	10.3	11.7	14.5	20.2
331	11.7	9.1	10.3	11.7	14.5	20.2
332	22.7	9.1	10.3	11.7	14.5	20.2
336	9.9	8.2	9.1	10.2	12.3	16.1
344	4.0	9.1	10.3	11.7	14.5	20.2
352	6.9	6.6	7.8	9.2	10.8	13.4
353	6.9	6.6	7.8	9.2	10.8	13.4

TABLE V.3 (Continued)

RUN NO. 3 1994 TRANSIT NETWORK PAGE 4

LINK NO.	1994 SPEED	SPEED REQ'D TO ATTAIN VARIOUS MODE SPLITS 20%	30%	40%	50%	60%
354	7.0	6.6	7.8	9.2	10.8	13.4
355	7.0	6.6	7.8	9.2	10.8	13.4
361	8.6	9.8	11.2	13.0	15.8	20.0
363	7.4	9.8	11.2	13.0	15.8	20.0
364	8.4	9.8	11.2	13.0	15.8	20.0
365	12.7	9.8	11.2	13.0	15.8	20.0
366	11.5	9.8	11.2	13.0	15.8	20.0
368	11.4	9.8	11.2	13.0	15.8	20.0
370	9.8	9.8	11.2	13.0	15.8	20.0
373	9.8	4.6	5.4	6.3	7.0	10.4
376	13.5	6.3	7.1	8.0	9.7	13.0
377	10.4	7.7	9.0	10.6	13.0	17.1
378	13.6	10.4	12.1	14.4	18.0	24.0
386	10.2	10.4	12.1	14.4	18.0	24.0
389	11.4	7.7	9.0	10.6	13.0	17.1
390	11.3	7.7	9.0	10.6	13.0	17.1
391	10.8	7.7	9.0	10.6	13.0	17.1
394	10.9	7.7	9.0	10.6	13.0	17.1
412	12.7	7.8	8.6	9.7	11.8	15.5
413	15.4	7.8	8.6	9.7	11.8	15.5
414	10.8	7.8	8.6	9.7	11.8	15.5
415	5.7	7.8	8.6	9.7	11.8	15.5
433	10.1	9.8	11.2	13.0	15.8	20.0
434	9.0	9.8	11.2	13.0	15.8	20.0
436	12.3	5.9	6.7	7.6	9.4	13.0
437	10.8	5.9	6.7	7.6	9.4	13.0
438	11.5	5.9	6.7	7.6	9.4	13.0
442	10.2	9.8	11.2	13.0	15.8	20.0
443	10.4	9.8	11.2	13.0	15.8	20.0
448	10.2	9.8	11.2	13.0	15.8	20.0
449	10.8	9.8	11.2	13.0	15.8	20.0
450	10.2	9.8	11.2	13.0	15.8	20.0
451	10.5	9.8	11.2	13.0	15.8	20.0
454	12.0	9.1	10.6	12.5	15.5	20.4
457	12.3	9.1	10.6	12.5	15.5	20.4
458	10.1	9.1	10.6	12.5	15.5	20.4
461	8.1	6.3	7.1	8.0	9.7	13.0
462	12.9	6.3	7.1	8.0	9.7	13.0
465	12.7	7.7	9.0	10.6	13.0	17.1
466	10.3	7.7	9.0	10.6	13.0	17.1
467	10.4	7.7	9.0	10.6	13.0	17.1
470	15.0	6.0	6.7	7.6	9.4	12.7
471	12.0	6.0	6.7	7.6	9.4	12.7
474	10.0	7.7	9.0	10.6	13.0	17.1
475	12.7	7.7	9.0	10.6	13.0	17.1
476	13.1	7.7	9.0	10.6	13.0	17.1
477	12.7	7.7	9.0	10.6	13.0	17.1
480	8.1	6.3	7.1	8.0	9.7	13.0
481	8.0	6.3	7.1	8.0	9.7	13.0
482	8.1	6.3	7.1	8.0	9.7	13.0
483	8.3	6.3	7.1	8.0	9.7	13.0
484	8.1	6.3	7.1	8.0	9.7	13.0

TABLE V.3 (Continued)

RUN NO. 3 1994 TRANSIT NETWORK PAGE 5

LINK NO.	1994 SPEED	SPEED REQ D TO ATTAIN VARIOUS MODE SPLITS 20%	30%	40%	50%	60%
485	8.1	6.3	7.1	8.0	9.7	13.0
492	9.4	5.3	6.0	6.8	8.4	11.6
495	10.5	10.4	12.1	14.4	18.0	24.0
498	9.2	5.3	6.0	6.8	8.4	11.6
499	9.0	5.3	6.0	6.8	8.4	11.6
502	9.6	5.3	6.0	6.8	8.4	11.6
503	9.0	5.3	6.0	6.8	8.4	11.6
507	9.9	6.6	7.5	8.7	11.0	16.1
508	10.3	7.1	8.2	9.6	11.9	16.1
513	13.7	7.1	8.2	9.6	11.9	15.5
514	13.4	7.1	8.2	9.6	11.9	15.5
515	12.7	7.1	8.2	9.6	11.9	15.5
516	13.4	7.1	8.2	9.6	11.9	15.5
517	13.3	7.1	8.2	9.6	11.9	15.5
520	13.4	10.4	12.1	14.4	18.0	24.0
521	12.0	10.4	12.1	14.4	18.0	24.0
522	12.0	10.4	12.1	14.4	18.0	24.0
523	13.1	10.4	12.1	14.4	18.0	24.0
524	13.4	10.4	12.1	14.4	18.0	24.0
525	13.1	10.4	12.1	14.4	18.0	24.0
526	13.8	10.4	12.1	14.4	18.0	24.0
529	11.5	6.9	8.1	9.7	12.2	16.6
530	11.1	6.9	8.1	9.7	12.2	16.6
533	10.9	6.9	8.1	9.7	12.2	16.6
534	11.2	6.9	8.1	9.7	12.2	16.6
546	11.6	10.4	11.5	12.8	15.2	19.5
598	10.3	7.6	8.5	9.3	10.5	13.2
608	37.1	10.4	11.5	12.8	15.2	19.5
610	31.0	10.4	11.5	12.8	15.5	20.4
612	18.0	10.4	11.5	12.8	15.5	20.4
614	32.8	10.4	11.5	12.8	15.5	20.4
616	22.7	10.4	11.5	12.8	15.5	20.4
618	13.1	10.4	11.5	13.2	16.7	24.2
619	17.0	10.4	11.5	13.2	16.7	24.2
624	19.0	9.1	10.7	12.7	16.0	21.5
626	27.2	9.1	10.7	12.7	16.0	21.5
629	15.8	9.1	10.7	12.7	16.0	21.5
630	29.3	9.1	10.7	12.7	16.0	21.5
633	26.3	10.1	11.5	13.2	16.7	24.2
635	22.2	10.1	11.5	13.2	16.7	24.2
637	30.0	7.6	8.6	9.6	11.7	15.6
639	33.5	7.6	8.6	9.6	11.7	15.6
640	10.9	10.1	11.5	13.2	16.7	24.2
641	10.4	10.1	11.5	13.2	16.7	24.2
651	9.5	9.1	10.7	12.7	16.0	21.5
652	11.0	6.3	7.1	7.7	8.6	10.6
653	10.8	9.1	10.7	12.7	16.0	21.5
656	8.7	9.1	10.3	11.7	14.5	20.2
662	41.5	6.2	7.3	8.5	9.8	12.0

TABLE V.4

RUN 3 LINKS IN ASCENDING ORDER OF LOAD

LINKS IN ASCENDING ORDER OF LOAD PAGE 1

LINK	TRIPS	LINK LENGTH	EXISTING TIME	EXISTING SPEED
223	6	0.26	1.5	10.4
241	6	0.33	1.3	15.2
251	8	0.14	1.0	8.4
252	8	0.33	1.2	16.5
448	18	0.34	2.0	10.2
449	18	0.27	1.5	10.8
450	18	0.34	2.0	10.2
451	18	0.70	4.0	10.5
546	19	0.31	1.6	11.6
608	19	1.36	2.2	37.1
41	30	0.09	0.5	10.8
42	30	0.22	1.3	10.2
255	36	0.95	4.0	14.2
480	38	0.27	2.0	8.1
481	38	0.36	2.7	8.0
454	44	0.52	2.6	12.0
457	44	0.43	2.1	12.3
458	44	0.49	2.9	10.1
413	50	0.36	1.4	15.4
45	52	0.50	2.3	13.0
46	52	1.23	4.0	18.4
301	56	0.40	1.9	12.6
302	56	0.07	0.3	14.0
303	56	0.16	0.8	12.0
246	57	0.72	2.5	17.3
412	59	0.34	1.6	12.8
256	62	0.35	1.5	14.0
257	62	0.32	1.3	14.8
258	62	0.28	1.2	14.0
373	73	0.18	1.1	9.8
470	73	0.30	1.2	15.0
471	73	0.30	1.5	12.0
502	76	0.32	2.0	9.6
503	76	0.18	1.2	9.0
610	76	0.93	1.8	31.0
309	81	0.33	1.1	18.0
310	81	0.33	1.1	18.0
598	82	0.43	2.5	10.3
662	82	0.90	1.3	41.5
513	83	0.41	1.8	13.7
514	83	0.49	2.2	13.4
515	83	0.19	0.9	12.7
516	83	0.38	1.7	13.4
517	83	0.31	1.4	13.3
305	88	0.26	1.2	13.0
306	88	0.43	2.0	12.9
436	88	0.43	2.1	12.3
437	88	0.18	1.0	10.8
438	88	0.25	1.3	11.5
104	90	0.10	0.9	6.7
117	90	0.31	1.9	9.8
118	90	0.47	2.5	11.3
120	90	0.78	5.0	9.4
121	90	0.29	1.0	17.4

TABLE V.4 (Continued)

LINKS IN ASCENDING ORDER OF LOAD PAGE 2

LINK	TRIPS	LINK LENGTH	EXISTING TIME	EXISTING SPEED
121	90	0.29	1.0	17.4
507	92	0.33	2.0	9.9
150	94	0.20	1.0	12.0
210	95	0.43	1.5	17.2
211	95	0.11	0.4	16.5
212	95	0.44	1.5	17.6
474	96	0.45	2.7	10.0
475	96	0.19	0.9	12.7
476	96	0.48	2.2	13.1
477	96	0.19	0.9	12.7
125	97	0.27	1.2	13.5
201	97	1.00	5.2	11.5
612	97	0.36	1.2	18.0
3	106	0.58	3.5	9.9
4	106	0.20	1.2	10.0
5	106	0.12	0.8	9.0
151	106	0.37	1.8	12.3
259	107	0.58	2.5	13.9
260	107	3.40	17.7	11.5
31	109	0.25	1.0	15.0
32	109	0.14	1.2	7.0
33	109	0.14	1.1	7.6
34	109	0.21	1.7	7.4
282	116	0.62	3.6	10.3
336	123	0.53	3.2	9.9
331	127	0.68	3.5	11.7
51	128	0.21	0.8	15.7
533	130	0.31	1.7	10.9
534	130	0.30	1.6	11.2
213	134	0.28	1.0	16.8
214	134	0.25	2.9	5.2
215	134	0.51	1.8	17.0
216	134	0.38	1.4	16.3
314	137	0.31	1.6	11.6
315	137	0.39	2.2	10.6
316	137	0.23	1.3	10.6
317	137	0.20	1.1	10.9
318	137	0.06	0.4	9.0
482	140	0.38	2.8	8.1
616	143	0.53	1.4	22.7
182	144	0.26	1.0	15.6
183	144	0.13	0.6	13.0
184	144	0.35	1.6	13.1
198	157	2.84	14.0	12.2
152	161	0.34	1.6	12.8
92	164	0.56	3.1	10.8
414	164	0.18	1.0	10.8
124	169	0.51	2.2	13.9
442	171	0.56	3.3	10.2
443	171	0.26	1.5	10.4
108	174	0.42	2.0	12.6
109	174	0.10	0.5	12.0
110	174	0.31	1.5	12.4
168	174	0.10	0.5	12.0

TABLE V.4 (Continued)

LINKS IN ASCENDING ORDER OF LOAD   PAGE 3

LINK	TRIPS	LINK LENGTH	EXISTING TIME	EXISTING SPEED
168	174	0.10	0.5	12.0
206	174	0.06	0.4	9.0
278	174	0.55	2.5	13.2
279	174	0.42	1.9	13.3
520	176	0.49	2.2	13.4
521	176	0.10	0.5	12.0
522	176	0.10	0.5	12.0
523	176	0.70	3.2	13.1
524	176	0.56	2.5	13.4
525	176	0.24	1.1	13.1
526	176	0.23	1.0	13.8
153	179	0.26	1.2	13.0
154	179	0.26	1.2	13.0
155	179	0.18	0.9	12.0
156	179	0.21	1.0	12.6
157	179	0.23	1.0	13.8
158	179	0.31	1.4	13.3
159	179	0.23	0.9	15.3
160	179	0.21	0.8	15.7
161	179	0.35	1.4	15.0
217	182	0.73	2.6	16.8
218	182	0.10	0.4	15.0
219	182	0.27	1.0	16.2
220	182	0.26	0.9	17.3
295	184	0.20	0.7	17.1
296	184	0.36	1.3	16.6
297	184	0.50	1.9	15.8
298	184	0.66	2.5	15.8
190	194	0.48	2.7	10.7
37	197	0.29	1.7	10.2
38	197	0.29	1.7	10.2
273	199	0.54	2.5	13.0
197	202	0.35	1.8	11.7
465	206	0.19	0.9	12.7
187	208	1.24	6.6	11.3
188	208	0.59	3.3	10.7
189	208	0.16	0.8	12.0
224	208	0.26	1.5	10.4
225	208	0.10	0.6	10.0
226	208	0.41	2.4	10.2
80	216	0.28	1.4	12.0
529	216	0.21	1.1	11.5
530	216	0.24	1.3	11.1
614	224	1.04	1.9	32.8
324	231	0.31	1.6	11.6
344	231	0.06	0.9	4.0
498	238	0.26	1.7	9.2
499	238	0.18	1.2	9.0
433	243	0.37	2.2	10.1
434	243	0.24	1.6	9.0
652	247	0.11	0.6	11.0
135	249	0.42	2.3	11.0
136	249	0.52	2.9	10.8
415	252	0.39	4.0	5.7

TABLE V.4 (Continued)

LINKS IN ASCENDING ORDER OF LOAD PAGE 4

LINK	TRIPS	LINK LENGTH	EXISTING TIME	EXISTING SPEED
415	252	0.38	4.0	5.7
483	265	0.25	1.8	8.3
484	265	0.38	2.8	8.1
485	265	0.19	1.4	8.1
176	269	0.25	1.2	12.5
177	269	0.67	3.1	13.0
178	269	0.16	0.7	13.7
179	269	0.20	0.9	13.3
283	278	0.47	2.7	10.4
284	278	0.30	1.7	10.6
466	279	0.12	0.7	10.3
467	279	0.19	1.1	10.4
88	292	0.16	0.9	10.7
89	292	0.55	3.1	10.6
84	302	0.95	3.9	14.6
508	307	1.20	7.0	10.3
492	312	0.36	2.3	9.4
137	313	0.17	1.0	10.2
361	314	0.33	2.3	8.6
142	334	1.50	8.4	10.7
394	349	0.60	3.3	10.9
332	354	1.93	5.1	22.7
656	354	0.13	0.9	8.7
76	357	0.22	1.1	12.0
77	357	0.11	0.5	13.2
651	367	0.30	1.9	9.5
274	373	0.30	1.8	10.0
171	381	0.40	1.9	12.6
172	381	0.17	0.8	12.7
461	381	0.19	1.4	8.1
462	381	0.28	1.3	12.9
285	382	0.20	1.2	10.0
83	384	0.22	1.2	11.0
141	398	0.21	0.8	15.7
18	418	0.27	1.1	14.7
95	419	0.27	2.3	7.0
96	419	0.30	1.4	12.9
24	420	0.29	1.8	9.7
144	443	0.14	0.9	9.3
637	455	0.85	1.7	30.0
639	455	1.06	1.9	33.5
495	478	0.93	5.3	10.5
21	479	0.19	1.0	11.4
364	512	0.07	0.5	8.4
365	512	0.72	3.4	12.7
366	512	0.21	1.1	11.5
368	512	0.19	1.0	11.4
370	512	0.41	2.5	9.8
63	520	0.14	1.7	4.9
64	520	0.14	1.8	4.7
65	520	0.08	0.9	5.3
66	520	0.08	0.9	5.3
145	524	0.15	0.9	10.0
146	524	0.08	0.6	8.0

TABLE V.4 Continued

LINKS IN ASCENDING ORDER OF LOAD PAGE 5

LINK	TRIPS	LINK LENGTH	EXISTING TIME	EXISTING SPEED
146	524	0.08	0.6	8.0
389	524	0.19	1.0	11.4
390	524	0.17	0.9	11.3
143	528	0.21	1.2	10.5
25	529	0.36	3.0	7.2
386	530	0.46	2.7	10.2
286	566	0.21	1.2	10.5
287	566	0.31	1.5	12.4
288	566	0.31	1.5	12.4
363	566	0.31	2.5	7.4
73	598	0.25	1.3	11.5
653	614	0.18	1.0	10.8
61	644	0.14	1.7	4.9
376	665	0.81	3.6	13.5
26	738	0.19	1.6	7.1
27	738	0.15	1.4	6.4
60	744	0.15	0.8	11.2
11	753	0.13	0.6	13.0
12	753	0.43	2.1	12.3
13	753	0.18	0.9	12.0
391	836	0.47	2.6	10.8
635	836	0.48	1.3	22.2
53	863	0.42	2.0	12.6
54	863	0.75	2.5	18.0
55	863	1.01	3.4	17.8
56	863	0.52	4.1	7.6
352	970	0.08	0.7	6.9
353	970	0.08	0.7	6.9
354	970	0.14	1.2	7.0
355	970	0.14	1.2	7.0
624	1050	0.38	1.2	19.0
626	1050	0.68	1.5	27.2
629	1050	0.29	1.1	15.8
630	1050	0.83	1.7	29.3
633	1149	0.70	1.6	26.3
641	1163	0.19	1.1	10.4
377	1501	0.19	1.1	10.4
14	1650	0.33	3.0	6.6
619	1656	0.34	1.2	17.0
6	1756	0.21	1.9	6.6
618	1986	0.24	1.1	13.1
378	2031	0.68	3.0	13.6
640	2213	0.20	1.1	10.9
7	3787	0.13	1.1	7.1

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Given transit network data and established Mode Split relationships, the analysis technique developed in this thesis can be used to determine, for each link in the system, the running speed required to attain a desired uniform level of mode split.

It is perhaps an anomaly that the most useful feature of the analysis is the ability to predict a failure. The rapid transit system tested did not "fail" in that the links tested could operate at optimum operating speeds, which were sufficient to attract a high (50 to 60%) percentage of trips as transit riders. Since a real rapid transit system is operated at its mechanically optimum acceleration, running speed, deceleration, and station dwell, the most useful information to transportation planners would be whether the resultant average operating speed were not sufficient to attract a level of ridership sufficient to justify the cost of the facility.

The goals of this thesis which were obtained successfully are as follows:

1. A basic test transit network and trip data file was developed to be easily expanded or changed for testing transit alternatives changes to components of the excess travel time of a transit trip.

2. The "Required Speed" program, which in this analysis was used with Edmonton data, could be used by any city by substituting the mode split relationships of the city and using the minimum trip paths of that city's network as found by the "Tree" and "Path" programs.

It is recommended that:

1. Test networks should have the centroids located <u>off</u> the network, connected to it by dummy links representing the portions of the excess travel time which occur at the beginning of a trip. This would simplify the testing of alternatives.

2. Future work to confirm the value of reiteration of mode split relationships for transit network analysis should be carried out. These future analysis should consider two aspects in addition to operating speed.

    a. Excess Travel Time. The possibility of reducing total trip time by reducing waiting time and/or eliminating transfers should be considered prior to analysis of operating speeds.

    b. Actual Ridership. The actual number of riders who would benefit by any proposed change should be considered to measure the benefits that must be considered relative to the cost of any suggested improvements.

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APPENDIX A

SOURCE DATA

TABLE A.1

HOUSE VALUE TABLE AND ZONE-CENTROID EQUIVALENCE

HOUSE VALUE TABLE

ORIGIN CENTROID	ORIGIN ZONE	HOUSE VALUE	ORIGIN CENTROID	ORIGIN ZONE	HOUSE VALUE	ORIGIN CENTROID	ORIGIN ZONE	HOUSE VALUE
6	110	12591	44	910	28228	100	2130	11167
7	120	11594	45	920	18299	101	2140	10855
8	140	9631	46	930	17455	103	2220	25160
10	150	8306	47	940	35196	104	2230	21353
11	210	13534	50	1010	12616	106	2250	33133
12	220	14204	51	1020	12616	107	2310	12750
13	230	12792	52	1030	13998	108	2320	12669
14	240	14505	53	1040	18811	109	2330	13107
15	250	14504	54	1110	8239	110	2340	13793
16	260	10218	55	1120	8239	111	2350	13304
17	310	17945	56	1130	8239	112	2360	15010
18	320	17945	57	1140	8239	113	2370	14663
19	330	17945	58	1150	11077	114	2410	10796
20	340	18550	59	1160	10262	115	2420	10919
21	410	9629	60	1170	11892	116	2430	12172
23	430	10840	66	1310	12909	117	2440	15233
24	440	15876	67	1320	13081	118	2450	13342
25	510	9433	68	1330	12367	119	2460	13729
26	520	9382	69	1340	13722	120	2470	11659
28	540	14776	70	1410	14857	121	2510	13650
29	550	9551	71	1420	14857	122	2520	15398
30	560	9985	72	1430	13575	123	2530	13531
33	710	9752	73	1440	11499	124	2540	13335
34	720	12347	75	1520	9720	126	2610	13618
35	730	11897	77	1540	12847	127	2620	16753
36	810	13985	78	1550	11499	128	2630	14636
37	820	13427	80	1620	11091	129	2640	15545
38	830	15508	81	1630	11482	130	2710	17476
39	840	15508	96	2010	12669	131	2720	16257
41	860	12526	97	2020	15550	141	3010	17518
42	870	14762	98	2110	11843			
43	880	12708	99	2120	9514			

University of Alberta
Department of Computing Science

TABLE A.2.1

TRAVEL TIME TABLE - DESTINATION ZONE 1

ORIGIN CENTROID	TRANSIT TOTAL TIME	AUTO TOTAL TIME	ORIGIN CENTROID	TRANSIT TOTAL TIME	AUTO TOTAL TIME	ORIGIN CENTROID	TRANSIT TOTAL TIME	AUTO TOTAL TIME
6	14.8	11.1	44	29.3	17.9	100	25.4	10.7
7	16.4	12.1	45	32.8	19.3	101	27.5	11.2
8	15.4	11.0	46	39.0	20.5	103	32.9	13.7
10	18.1	11.2	47	42.3	20.8	104	31.9	14.7
11	15.6	9.7	50	50.2	23.5	106	38.8	18.4
12	20.1	13.7	51	44.2	21.6	107	24.8	13.4
13	23.2	12.3	52	48.3	24.5	108	32.3	13.2
14	23.8	14.4	53	48.3	23.5	109	30.4	15.3
15	24.7	16.0	54	39.9	21.5	110	32.8	15.0
16	25.7	16.3	55	51.4	24.0	111	39.1	14.1
17	13.6	10.2	56	34.4	20.7	112	40.0	15.6
18	14.9	10.8	57	57.1	22.4	113	34.0	16.8
19	16.9	12.1	58	53.2	21.3	114	23.7	13.5
20	20.8	14.9	59	39.7	18.7	115	28.9	12.1
21	22.7	15.3	60	44.5	20.4	116	31.5	13.9
23	23.8	16.7	66	39.8	22.9	117	33.2	15.0
24	29.3	18.7	67	38.3	22.7	118	39.3	16.4
25	21.9	14.6	68	34.1	21.5	119	32.6	15.4
26	26.6	15.1	69	33.8	20.2	120	30.7	14.3
28	30.3	18.6	70	34.3	19.6	121	22.6	10.5
29	36.0	18.8	71	39.3	20.7	122	26.9	11.1
30	31.9	16.9	72	42.5	22.2	123	26.0	11.5
33	30.9	18.4	73	37.7	23.1	124	32.9	13.1
34	30.2	18.2	75	36.5	19.3	126	27.1	12.7
35	24.5	15.1	77	32.1	22.0	127	24.4	14.8
36	33.4	18.6	78	42.0	24.4	128	32.6	18.7
37	37.2	19.0	80	37.0	23.4	129	33.4	15.9
38	37.8	17.7	81	28.0	21.4	130	31.8	13.7
39	31.0	17.1	96	25.2	11.4	131	34.8	13.3
41	28.1	15.9	97	18.1	11.4	141	38.0	17.1
42	32.4	17.4	98	17.9	10.5			
43	31.6	17.4	99	19.7	8.9			

TABLE A.2.2

TRAVEL TIME TABLE - DESTINATION ZONE 2

ORIGIN CENTROID	TRANSIT TOTAL TIME	AUTO TOTAL TIME	ORIGIN CENTROID	TRANSIT TOTAL TIME	AUTO TOTAL TIME	ORIGIN CENTROID	TRANSIT TOTAL TIME	AUTO TOTAL TIME
6	21.4	10.7	44	23.6	16.1	100	33.4	14.3
7	24.0	11.7	45	28.4	17.5	101	34.7	14.8
8	22.4	13.5	46	39.0	19.7	103	33.6	13.6
10	27.0	14.2	47	42.3	20.0	104	39.6	15.7
11	23.3	7.7	50	52.2	22.7	106	46.5	19.4
12	26.4	12.2	51	45.2	20.8	107	31.9	14.5
13	29.4	9.3	52	50.3	23.7	108	40.6	14.5
14	31.0	11.3	53	49.3	22.7	109	38.1	16.4
15	31.9	13.1	54	40.1	19.3	110	41.6	16.1
16	34.4	15.7	55	51.6	21.8	111	46.9	15.3
17	10.3	8.5	56	34.6	18.9	112	48.0	17.4
18	12.4	9.0	57	57.1	20.9	113	43.0	17.8
19	12.9	10.3	58	53.2	21.3	114	34.0	16.5
20	17.6	13.1	59	39.5	18.8	115	37.7	15.7
21	29.2	15.8	60	44.3	21.2	116	39.7	17.5
23	31.1	17.2	66	47.1	20.6	117	42.7	18.5
24	35.8	19.2	67	44.6	20.3	118	49.6	19.5
25	28.0	14.3	68	41.9	20.8	119	43.1	18.4
26	33.3	14.5	69	41.7	19.4	120	39.1	17.5
28	36.7	18.6	70	42.2	18.9	121	32.2	14.1
29	43.8	18.2	71	47.2	20.1	122	35.2	14.7
30	40.1	16.1	72	49.5	21.6	123	36.4	15.1
33	38.0	16.1	73	46.7	22.5	124	42.1	16.7
34	26.7	15.4	75	43.9	19.8	126	36.1	16.3
35	19.8	12.3	77	40.9	22.5	127	31.4	18.4
36	36.5	17.8	78	51.0	23.8	128	39.6	21.4
37	38.6	18.3	80	45.0	24.1	129	41.8	19.6
38	36.8	17.6	81	36.0	23.2	130	40.8	17.3
39	32.0	17.0	96	32.3	12.6	131	42.8	16.9
41	34.2	15.8	97	25.9	12.4	141	47.0	18.2
42	31.9	17.4	98	27.4	14.1			
43	30.8	17.4	99	27.9	12.5			

TABLE A.2.3

TRAVEL TIME TABLE - DESTINATION ZONE 4

ORIGIN CENTROID	TRANSIT TOTAL TIME	AUTO TOTAL TIME	ORIGIN CENTROID	TRANSIT TOTAL TIME	AUTO TOTAL TIME	ORIGIN CENTROID	TRANSIT TOTAL TIME	AUTO TOTAL TIME
6	26.6	12.1	44	31.6	15.7	100	36.4	12.3
7	28.2	13.1	45	37.0	17.1	101	37.7	12.8
8	29.4	14.3	46	47.0	19.3	103	27.6	12.0
10	28.0	11.9	47	50.3	19.5	104	32.6	13.4
11	27.8	10.1	50	54.1	22.2	106	39.5	17.1
12	30.9	13.7	51	47.1	20.4	107	25.9	12.1
13	33.9	11.0	52	52.2	23.3	108	44.6	12.3
14	30.7	12.1	53	51.2	22.3	109	32.1	14.0
15	34.9	14.0	54	42.0	18.9	110	34.6	13.7
16	39.4	17.3	55	53.5	21.3	111	49.9	13.1
17	16.3	8.0	56	36.5	18.5	112	52.0	15.4
18	17.4	8.6	57	59.0	20.6	113	35.0	15.8
19	19.3	9.9	58	55.1	19.3	114	35.0	14.3
20	22.4	12.7	59	41.4	16.8	115	38.7	13.7
21	32.3	17.0	60	46.2	19.4	116	40.7	15.5
23	35.6	18.4	66	49.1	22.2	117	43.7	16.6
24	39.3	20.3	67	47.6	22.0	118	50.6	17.1
25	34.2	15.7	68	43.9	22.1	119	44.1	16.4
26	38.1	15.9	69	43.7	20.8	120	41.1	15.3
28	41.7	19.3	70	44.2	20.2	121	35.2	12.1
29	46.8	19.5	71	49.2	21.5	122	38.2	12.8
30	41.8	17.4	72	51.5	23.0	123	37.4	13.2
33	40.4	17.8	73	47.7	23.9	124	44.1	14.7
34	29.1	16.2	75	46.9	21.0	126	38.2	14.3
35	24.6	12.9	77	43.9	23.7	127	35.4	15.6
36	45.9	17.6	78	53.0	25.2	128	43.6	19.4
37	45.6	18.1	80	49.0	25.1	129	44.4	17.6
38	42.8	16.8	81	40.0	24.0	130	42.8	15.3
39	38.0	16.2	96	26.1	10.4	131	45.8	14.9
41	40.8	14.9	97	17.7	9.7	141	40.0	15.8
42	37.7	15.4	98	27.8	11.5			
43	38.8	15.4	99	30.9	10.5			

TABLE A.3

TRIP DATA

Origin Centroid	Destination 1 Total Trips	Destination 1 Transit Trips	Destination 2 Total Trips	Destination 2 Transit Trips	Destination 4 Total Trips	Destination 4 Transit Trips
6	129	80	17	15	26	14
7	458	302	28	19	26	13
8	142	87	37	21	29	10
10	210	132	51	23	34	19
11	340	173	82	31	63	20
12	160	88	33	10	34	13
13	285	145	82	10	83	13
14	62	26	10	3	16	2
15	143	37	36	5	40	11
16	185	111	46	17	26	8
17	178	109	92	22	128	17
18	276	182	97	33	94	27
19	245	108	58	18	52	18
20	202	103	65	26	43	19
21	158	70	32	14	31	10
23	220	108	44	14	33	8
24	259	127	64	18	52	22
25	379	246	85	41	100	43
26	328	207	37	13	59	29
28	162	71	27	6	38	11
29	132	69	33	15	26	9
30	232	121	71	22	57	28
33	128	61	39	7	24	15
34	323	184	98	26	106	39
35	343	158	96	30	82	34
36	206	66	64	15	86	15
37	45	8	13	1	13	4
38	133	37	40	5	48	14
39	57	16	16	3	16	1
41	202	79	66	19	61	16
42	309	99	97	18	85	9
43	391	109	91	14	127	23
44	230	21	45	3	28	2
45	226	79	62	17	39	11
46	363	65	109	7	110	11
47	166	13	51	2	21	1
50	195	31	79	6	66	2
51	103	36	44	8	32	6
52	173	36	53	1	50	2
53	64	0	32	0	0	0
54	31	6	21	1	1	0
55	93	35	37	12	33	4
56	21	10	11	7	7	4

TABLE A.3 (Cont'd)

TRIP DATA

Origin Centroid	Destination 1 Total Trips	Destination 1 Transit Trips	Destination 2 Total Trips	Destination 2 Transit Trips	Destination 4 Total Trips	Destination 4 Transit Trips
57	90	8	24	1	23	0
58	127	29	53	5	29	4
59	100	34	39	5	22	7
60	90	19	39	6	29	4
66	408	155	117	27	81	19
67	303	24	90	27	69	21
68	227	91	60	13	48	14
69	339	136	69	83	63	14
70	222	84	41	10	41	12
71	331	142	86	22	76	21
72	80	38	17	3	44	16
73	106	45	31	9	20	8
75	212	106	51	16	40	17
77	175	94	49	8	28	4
78	54	21	18	2	8	1
80	183	89	72	15	35	15
81	204	94	56	14	48	17
96	135	59	25	4	49	9
97	140	56	38	8	47	10
98	337	216	81	29	85	41
99	87	43	15	5	8	6
100	252	136	63	16	59	25
101	102	54	25	10	19	7
103	105	10	34	1	13	1
104	148	50	32	7	41	3
106	35	3	11	0	10	1
107	180	88	55	15	71	13
108	92	57	18	9	23	7
109	180	74	50	6	49	10
110	146	79	34	13	58	20
111	72	35	11	4	20	6
112	49	16	16	2	19	0
113	110	38	34	4	49	3
114	133	85	36	10	46	22
115	130	90	27	10	28	13
116	139	60	30	8	26	7
117	164	79	59	9	41	11
118	72	31	23	7	19	3
119	154	88	45	7	54	9
120	195	101	47	10	47	16
121	170	63	41	4	35	9
129	402	145	113	20	128	13
130	238	69	86	11	64	6
131	342	109	107	10	101	12

TABLE A.4

TRANSIT TRIPS TO C.S.A. IN A.M. PEAK HOUR - 1964

Zone	Actual Trips	Predicted Trips	Zone	Actual Trips	Predicted Trips
110	80	82	1330	91	112
120	104	88	1340	136	152
140	87	90	1410	84	78
150	132	126	1420	142	93
210	173	163	1430	38	27
220	88	77	1440	45	30
230	145	100	1510	106	107
240	26	25	1540	95	93
250	37	63	1550	20	23
260	111	113	1620	99	90
310	108	103	1630	94	108
320	182	155	2010	59	57
330	108	135	2020	56	80
340	103	101	2110	206	182
410	69	98	2120	43	55
430	108	139	2130	136	128
440	127	111	2140	54	59
510	246	235	2220	10	9
520	207	184	2230	50	38
540	71	65	2250	3	3
550	69	66	2310	88	92
560	120	118	2320	57	27
710	61	75	2330	74	82
720	184	149	2340	82	57
730	158	161	2350	35	11
810	66	82	2360	16	8
820	8	14	2370	38	41
830	37	23	2410	85	85
840	16	18	2420	90	76
860	79	83	2430	60	63
870	99	93	2440	79	64
880	110	153	2450	31	27
910	21	21	2460	89	74
920	79	75	2470	101	94
930	65	62	2510	63	90
940	13	15	2520	69	62
960			2530	148	158
1010	31	41	2540	73	55
1020	36	27	2610	78	57
1030	36	34	2620	107	100
1040	0	6	2630	64	113
1110	6	16	2640	145	101
1120	35	32	2710	69	79
1130	10	12	2720	110	96
1140	8	14	3010	14	16
1150	55	23			
1160	34	37		7478	7316
1170	19	17			
1310	155	172			
1320	124	133			

TABLE A - 5

RELATIONSHIP OF AVERAGE HOUSE VALUE TO AVERAGE FAMILY INCOME FOR EDMONTON CENSUS DISTRICTS, 1961

LINEAR REGRESSION ANALYSIS - AVE. HOUSE VALUE VS. AVE. FAMILY INCOME - 1961 DATA

PAGE 1

AVE. HOUSE VALUE	AVE. FAMILY INCOME
13282.	4978.
14203.	4632.
11759.	5315.
10220.	4584.
12061.	4532.
11213.	4568.
12374.	5354.
14094.	5454.
9340.	4155.
10301.	4451.
12871.	5022.
11998.	5497.
13043.	5185.
12136.	3502.
12658.	5726.
18882.	7298.
17641.	5535.
9100.	3847.
18303.	8250.
23533.	8536.
13800.	5167.
12318.	5016.
10660.	5161.
14185.	5802.
15009.	5094.
22479.	7839.
12675.	5986.
13800.	4879.
11362.	4454.
11937.	5116.
14111.	5152.
12323.	4807.
13220.	4955.
13963.	5820.
16055.	5936.
25224.	6513.
11839.	3985.
24341.	8405.
16055.	6715.
16055.	5832.
16494.	6294.
14678.	5927.

REGRESSION LINE Y ON X

$$Y = 1780.7546 + 0.2601\ X$$

COEFFICIENT OF CORRELATION = 0.848

APPENDIX B

ACCURACY CHECK OF TEST NETWORK

TABLE B.1

FIELD CHECK OF LINK LENGTHS

Link	Run	Start	End	Distance (Miles)	Average	Corrected For + 2% Odometer Error	Length	Diff.
546	1	28.77	29.00	.23				
	2	48.10	40.85	.25	.24			
	3	62.92	63.17	.25		.78	.78	0
547	1	29.00	29.59	.59				
	2	40.85	41.41	.56	.56			
	3	63.17	63.73	.56				
548	1	29.59	29.79	.20				
	2	41.41	41.62	.21	.21	.21	.19	-.02
	3	63.73	63.45	.22				
454	1	29.79	30.32	.53				
	2	41.62	42.15	.53	.53	.52	.52	0
	3	63.95	64.48	.53				
457	1	30.32	30.77	.45				
	2	42.15	47.61	.46	.45	.44	.43	-.01
	3	64.48	64.92	.44				
458	1	30.77	31.28	.51				
	2	42.61	43.11	.50	.51	.50	.49	-.01
	3	64.92	65.45	.53				
423	1	31.28	31.55	.27				
	2	43.11	43.40	.29	.27	.27	.28	+.01
	3	65.45	65.71	.26				
425	1	31.86	32.05	.19				
	2	66.00	66.20	.20	.19	.19	.17	-.02
426	1	32.05	32.30	.25				
	2	43.89	44.14	.25	.25	.25	.25	0
	3	66.20	66.46	.26				
428	1	32.30	32.61	.31				
	2	44.14	44.45	.31	.31			
	3	67.51	67.83	.32				
373	1	32.61	32.85	.24				
	2	44.45	44.69	.24	.24	.54	.53	-.01
	3	67.83	68.09	.26				
364	1	32.85	32.92	.07				
	2	44.69	44.75	.06	.06	.06	.07	+.01
	3	68.09	68.15	.06				
404	1	32.92	33.68	.76				
	2	44.75	45.50	.75	.76	.75	.76	+.01
	3	69.85	70.61	.76				
365	1	35.40	36.36	.96				
	2	68.15	69.15	.98	.96	.94	.93	-.01
	3	77.15	78.09	.94				
363	1	36.45	36.78	.35				
	2	74.02	74.35	.33	.34	.33	.31	-.02
	3	76.75	77.09	.34				
415	1	36.78	37.18	.40				
	2	74.35	74.75	.40	.40	.39	.38	-.01
	3	76.35	76.76	.40				
414	1	37.18	37.35	.17				
	2	36.16	36.35	.19	.18	.18	.18	0
	3	80.14	80.32	.18				
413	1	37.35	37.74	.39				
	2	75.80	76.16	.36	.38	.37	.36	-.01
	3	80.32	80.70	.38				

TABLE B.2

EXAMPLE OF TEST OF NETWORK DATA

LINK NO	ORIGIN NODE	DEST NODE	LENGTH MI	TIME MIN	SPEED MPH
3	6	552	0.58	3.5	9.9
4	591	585	0.20	1.2	10.0
5	583	584	0.12	0.8	9.0
6	584	580	0.21	1.9	6.6
7	580	528	0.13	1.1	7.1
8	528	1	0.0	3.0	0.0
11	7	590	0.13	0.8	15.0
12	598	590	0.43	2.1	12.3
13	590	588	0.18	0.9	12.0
14	588	584	0.33	3.0	6.6
15	586	587	0.15	0.9	10.0
16	9	588	0.27	1.1	14.7
21	10	588	0.19	1.0	11.4
24	11	534	0.25	1.8	9.7
25	534	545	0.30	3.0	7.2
26	545	540	0.19	1.6	7.1
27	540	529	0.15	1.4	6.4
28	529	1	0.0	3.0	0.0
31	12	330	0.25	1.0	15.0
32	330	332	0.14	1.2	7.0
33	332	333	0.14	1.1	7.6
34	333	334	0.21	1.7	7.4
37	13	336	0.29	1.7	10.2
38	336	11	0.29	1.7	10.2
41	14	336	0.09	0.5	10.8
42	336	13	0.22	1.3	10.2
45	15	520	0.50	2.3	13.0
46	520	531	1.25	4.0	18.4
47	531	530	0.0	0.0	0.0
48	530	545	0.0	0.0	0.0
51	16	600	0.21	0.8	15.7
52	600	235	0.0	2.5	0.0
53	235	536	0.42	2.0	12.6
54	536	542	0.75	2.5	18.0
55	542	554	1.01	3.4	17.8
56	554	552	0.52	4.1	7.6
57	552	1	0.0	4.0	0.0
60	17	588	0.15	0.8	11.2
61	388	535	0.14	1.7	4.9
62	535	565	0.0	0.0	0.0
63	565	563	0.14	1.7	4.9
64	563	561	0.14	1.8	4.7
65	561	549	0.08	0.9	5.3
66	549	529	0.08	0.9	5.3
[illegible]	605	250	0.0	2.5	0.0
67	18	565	0.85	3.2	15.8
69	250	12	0.47	2.0	14.1
70	569	605	0.0	0.0	0.0
75	18	17	0.25	1.3	11.5
76	19	575	0.22	1.1	12.0
77	575	13	0.21	0.9	13.2
80	20	19	0.28	1.4	12.0
83	21	401	0.22	1.2	11.0
84	401	9	0.35	1.9	14.6

LINK NO	ORIGIN NODE	DEST NODE	LENGTH MI	TIME MIN	SPEED MPH
85	370	369	0.28	1.8	9.3
88	23	400	0.16	0.9	10.7
89	400	21	0.55	3.1	10.6
92	24	23	0.56	3.1	10.8
95	25	394	0.27	2.3	7.0
96	394	7	0.30	1.4	12.9
97	394	536	0.0	0.0	0.0
98	393	6	0.43	2.5	10.3
101	26	537	0.66	4.2	9.4
102	537	538	0.37	3.2	6.9
103	538	393	0.20	1.0	12.0
104	390	25	0.10	0.9	6.7
108	28	231	0.42	2.0	12.6
109	231	232	0.10	0.5	12.0
110	232	245	0.31	1.5	12.4
111	245	540	0.10	0.7	8.6
112	540	539	0.0	3.0	0.0
113	539	554	0.61	3.1	11.8
117	29	541	0.31	1.9	9.8
118	541	601	0.47	2.5	11.3
119	601	241	0.0	2.0	0.0
120	241	247	0.78	5.0	9.4
121	247	590	0.29	1.0	17.4
124	30	600	0.51	2.2	13.9
125	252	45	0.27	1.2	13.5
129	33	256	0.43	2.5	10.3
130	256	255	0.21	1.2	10.5
131	255	543	0.0	0.0	0.0
135	34	281	0.42	2.3	11.0
136	281	280	0.52	2.9	10.8
137	280	540	0.17	1.0	10.2
138	540	14	0.33	2.0	9.9
141	35	544	0.21	0.8	15.7
142	544	543	1.50	8.4	10.7
143	543	366	0.21	1.2	10.5
144	366	304	0.14	0.9	9.3
145	304	348	0.15	0.9	10.0
146	348	347	0.08	0.6	8.0
147	347	552	0.0	0.0	0.0
150	36	37	0.20	1.0	12.0
151	37	38	0.37	1.8	12.3
152	38	39	0.34	1.6	12.7
153	39	264	0.26	1.2	13.0
154	264	265	0.26	1.2	13.0
155	265	266	0.18	0.9	12.0
156	266	276	0.21	1.0	12.6
157	276	275	0.25	1.0	13.6
158	275	274	0.31	1.4	13.3
159	274	277	0.23	0.9	15.3
160	277	276	0.21	0.8	15.7
161	276	35	0.35	1.4	15.0
168	240	243	0.10	0.5	12.0
171	41	545	0.40	1.9	12.6
172	545	326	0.17	0.8	12.7

LINK NO	ORIGIN NODE	DEST NODE	LENGTH MI	TIME MIN	SPEED MPH
173	326	15	0.40	1.9	12.6
175	43	602	0.26	1.0	15.6
176	42	270	0.25	1.2	12.5
177	270	546	0.67	3.1	13.0
178	546	267	0.16	0.7	13.7
179	267	41	0.20	0.9	13.3
182	43	273	0.26	1.0	15.6
183	273	272	0.13	0.6	13.0
184	272	42	0.35	1.6	13.1
186	602	547	0.0	5.0	0.0
187	547	548	1.24	6.6	11.3
188	548	341	0.59	3.3	10.7
189	341	342	0.16	0.8	12.0
190	342	343	0.48	2.7	10.7
193	44	284	0.74	5.1	8.7
194	284	20	0.17	0.9	11.3
197	45	549	0.35	1.8	11.7
198	549	531	2.84	14.0	12.2
201	46	292	1.00	5.2	11.5
204	47	295	0.20	1.1	10.9
205	295	46	0.19	1.0	11.4
206	245	246	0.06	0.4	9.0
207	382	381	0.15	1.0	9.0
210	50	315	0.43	1.5	17.2
211	315	314	0.11	0.4	16.5
212	314	52	0.44	1.5	17.6
213	52	307	0.28	1.0	16.8
214	307	308	0.25	2.9	5.2
215	306	297	0.51	1.8	17.0
216	297	51	0.36	1.4	16.3
217	51	300	0.73	2.6	16.8
218	300	301	0.10	0.4	15.0
219	301	550	0.27	1.0	16.2
220	550	56	0.26	0.9	17.3
221	56	603	0.26	0.9	17.3
222	603	303	0.0	2.0	0.0
223	303	56	0.26	1.5	10.4
224	56	290	0.26	1.5	10.4
225	290	289	0.10	0.6	10.0
226	289	547	0.41	2.4	10.2
227	289	287	0.41	2.4	10.2
228	287	286	0.10	0.6	10.0
229	286	44	0.33	2.3	8.6
230	549	287	0.0	0.0	0.0
237	53	308	0.49	1.9	15.5
238	306	306	0.44	3.8	6.9
239	306	305	0.29	1.2	14.5
240	305	54	0.72	2.9	14.9
241	54	303	0.33	1.3	15.2
246	55	50	0.72	2.5	17.3
251	57	318	0.14	1.0	8.4
252	316	55	0.33	1.2	16.5
255	58	60	0.95	4.0	14.2
256	60	323	0.35	1.5	14.0

APPENDIX C

LISTING AND EXAMPLES OF TREE BUILDING AND MINIMUM PATH PROGRAMS

TABLE C.1

LISTING OF TREE BUILDING PROGRAM

```
C     THIS PROGRAMME BUILDS MINIMUM PATH TREES FROM AN ORIGIN NODE TO
C     ALL GIVEN NODES IN NETWORK AS DESTINATIONS
C     ALLOWANCE IS MADE FOR GAPS IN NODE AND/OR LINK NUMBER SEQUENCE
C     TRIP COST FUNCTION TO BE MINIMISED MAY BE TRIP TIME, TRIP DISTANCE
C     OR A COMBINATION OF TRIP TIME AND DISTANCE
C     PROGRAMME OUTPUT MAY BE A LISTING AND/OR MAGNETIC TAPE GIVING FOR
C     EACH ORIGIN NODE TO EVERY NETWORK NODE AS DESTINATIONS THE TOTAL
C     TRIP COST AND LAST APPROACH LINK TRAVELLED
C     PROGRAMME IS WRITTEN SO THAT IT MAY BE INTERRUPTED
C     SEE PROGRAMME DESCRIPTION FOR DEFINITION OF VARIABLES USED
     ODIMENSION KO(1000),LC(1000),LL(2000),LU(1000),LT(2000),
     1LCF(1000,4),LND(1000,4),LPT(1000,4),LMA(1000),MN(1000),KAB(1000),
     2LMW(1000)
      REWIND 3
      READ (5,1) LNK,NCR,NOD,LFT,LFD,NOC,NPR,NTA,NHN,LHN,KZA
    1 FORMAT (18I4)
      DO 2 I=1,NHN
      MN(I)=0
      LMA(I)=0
      LC(I)=0
      DO 3 K=1,4
      LCF(I,K)=0
      LND(I,K)=0
      LPT(I,K)=0
    3 CONTINUE
    2 CONTINUE
      IF (NOC-1)5,6,6
    5 DO 7 J=1,LNK
      READ(5,80)NO,ND,KS,KT,MW,MV,L
   80 FORMAT(2I5,I8,1X,I1,I7,1X,I2,I5)
      LT(L)=(10*KS)+KT
      LL(L)=(100*MW)+MV
      IF (LC(NO)-1)46,47,47
   46 KZA=KZA+1
      LMA(KZA)=NO
   47 LC(NO)=LC(NO)+1
      K=LC(NO)
      LND(NO,K)=ND
      LPT(NO,K)=L
      LCF(NO,K)=((LFT*LT(L))/600)+((LFD*LL(L))/100)
    7 CONTINUE
      DO 8 JJ=1,KZA
      I=LMA(JJ)
      WRITE (3) I,LC(I),(LND(I,K),LPT(I,K),LCF(I,K),K=1,4)
    8 CONTINUE
      GO TO 11
    6 DO 10 JJ=1,KZA
      READ (3) I,LC(I),(LND(I,K),LPT(I,K),LCF(I,K),K=1,4)
   10 CONTINUE
      DO 11 I=1,NCC
      READ(3)NNT,JW,(KAB(JJ),LT(JJ),LMA(JJ),JJ=1,JW)
   11 CONTINUE
      READ(5,1)NCO
      READ(5,1)(KAB(JJ),JJ=1,NCO)
      DO 48 JJ=1,NCO
      JV=KAB(JJ)
      MN(JV)=2
   48 CONTINUE
```

TABLE C.1 (Continued)

```
ISN 0048          IPAGE=1
ISN 0049          LINES=0
ISN 0050          WRITE(6,101)IPAGE
ISN 0051      101 FORMAT(1H1,10X,
                 1'MINIMUM PATH TREES - 1964 EDMONTON TRANSIT NETWORK',
                 250X,'PAGE',I5/)
ISN 0052        9 DO 12 J=1,LHN
ISN 0053          LL(J)=0
ISN 0054          LT(J)=0
ISN 0055       12 CONTINUE
ISN 0056          DO 13 I=1,NHN
ISN 0057          LMW(I)=0
ISN 0058          KAB(I)=0
ISN 0059          LMA(I)=0
ISN 0060          KD(I)=0
ISN 0061          LU(I)=0
ISN 0062       13 CONTINUE
ISN 0063          KP=0
ISN 0064          READ(5,82)NNT
ISN 0065       82 FORMAT(I5)
ISN 0066          IF(NNT-9998)81,15,16
ISN 0067       81 CONTINUE
ISN 0068          MM=LC(NNT)
ISN 0069          KD(NNT)=2
ISN 0070          TEST=999999
ISN 0071          DO 17 K=1,MM
ISN 0072          NN=LND(NNT,K)
ISN 0073          LL(NN)=LCF(NNT,K)
ISN 0074          KD(NN)=1
ISN 0075          KP=KP+1
ISN 0076          LMW(KP)=NN
ISN 0077          LU(NN)=LPT(NNT,K)
ISN 0078          IF (TEST-LL(NN))17,17,18
ISN 0079       18 TEST=LL(NN)
ISN 0080          NSF=NN
ISN 0081       17 CONTINUE
ISN 0082          LO=0
ISN 0083       35 MM=LC(NSF)
ISN 0084          DO 72 I=1,KP
ISN 0085          IF (LMW(I)-NSF)72,71,72
ISN 0086       71 MZ=I+1
ISN 0087          IF(MZ.GT.KP) GO TO 200
ISN 0089          GO TO 73
ISN 0090       72 CONTINUE
ISN 0091       73 DO 74 J=MZ,KP
ISN 0092          II=J-1
ISN 0093          LMW(II)=LMW(J)
ISN 0094       74 CONTINUE
ISN 0095      200 KP=KP-1
ISN 0096          DO 25 K=1,MM
ISN 0097          NN=LND(NSF,K)
ISN 0098          IF(KD(NN)-1)26,27,25
ISN 0099       26 LT(NN)=LL(NSF)+LCF(NSF,K)
ISN 0100          GO TO 28
ISN 0101       27 LT(NN)=LL(NSF)+LCF(NSF,K)
ISN 0102          IF(LL(NN)-LT(NN))25,29,28
ISN 0103       28 LL(NN)=LT(NN)
ISN 0104          KD(NN)=1
ISN 0105          KP=KP+1
```

TABLE C.1 (Continued)

```
ISN 0106          LMW(KP)=NN
ISN 0107          LU(NN)=LPT(NSF,K)
ISN 0108          GO TO 25
ISN 0109       29 WRITE (6,30)
ISN 0110       30 FORMAT (54H EQUAL COST ROUTE FROM NNT TO NN VIA THIS LINK OMITTED)
ISN 0111          WRITE (6,31)
ISN 0112       31 FORMAT (15H ORIG DEST LINK)
ISN 0113          WRITE (6,24) NNT,NN,LPT(NSF,K)
ISN 0114       24 FORMAT (3(1X,I6))
ISN 0115       25 CONTINUE
ISN 0116          KD(NSF)=2
ISN 0117          IF (MN(NSF) 1)50,50,51
ISN 0118       51 LG=LG+1
ISN 0119          IF (LG-NCD)50,25,25
ISN 0120       50 TEST=999999
ISN 0121          DO 32 II=1,KP
ISN 0122          I=LPW(II)
ISN 0123          IF(TEST-LL(I))32,32,60
ISN 0124       60 IF (LC(I) 1)61,34,34
ISN 0125       61 KD(I)=2
ISN 0126          IF (MN(I) 1)32,32,62
ISN 0127       62 LG=LG+1
ISN 0128          IF (LG-NCD)32,20,20
ISN 0129       34 TEST=LL(I)
ISN 0130          NSF=I
ISN 0131       32 CONTINUE
ISN 0132          GO TO 35
ISN 0133       20 DO 52 I=1,NNN
ISN 0134          KAB(I)=0
ISN 0135          LMA(I)=0
ISN 0136          LT(I)=0
ISN 0137       52 CONTINUE
ISN 0138          JW=0
ISN 0139          DO 53 JJ=1,NNN
ISN 0140          IF (KD(JJ)-1)53,53,54
ISN 0141       54 JW=JW+1
ISN 0142          KAB(JW)=JJ
ISN 0143          LT(JW)=LL(JJ)
ISN 0144          LMA(JW)=LU(JJ)
ISN 0145       53 CONTINUE
ISN 0146          JWCTR=1
ISN 0147          WRITE(6,102)NNT,JW
ISN 0148      102 FORMAT(///10X,'ORIGIN CENTROID',I5,10X,I5,2X,'LINKS'/)
ISN 0149          LINES=LINES+5
ISN 0150          GO TO 97
ISN 0151      100 WRITE(6,98)IPAGE
ISN 0152       98 FORMAT(1H1,60X,'PAGE',I5/)
ISN 0153          LINES=2
ISN 0154          WRITE(6,102)NNT,JW
ISN 0155       97 WRITE(6,103)
ISN 0156      103 FORMAT(6X,6(15HDEST. CUM. LAST,3X))
ISN 0157          LINES=LINES+1
ISN 0158          WRITE(6,104)
ISN 0159      104 FORMAT(6X,6(15HNODE  TIME LINK,3X))
ISN 0160          LINES=LINES+1
ISN 0161          DO 106 JJ=JWCTR,JW,6
ISN 0162          WRITE(6,105)KAB(JJ),LT(JJ),LMA(JJ),
                 1KAB(JJ+1),LT(JJ+1),LMA(JJ+1),
                 2KAB(JJ+2),LT(JJ+2),LMA(JJ+2),
                 3KAB(JJ+3),LT(JJ+3),LMA(JJ+3),
                 4KAB(JJ+4),LT(JJ+4),LMA(JJ+4),
                 5KAB(JJ+5),LT(JJ+5),LMA(JJ+5)
ISN 0163      105 FORMAT(6X,6(I4,I6,I5,3X))
ISN 0164          LINES=LINES+1
ISN 0165          IF(LINES.LE.54) GO TO 106
ISN 0167          IPAGE=IPAGE+1
ISN 0168          JWCTR=JJ
ISN 0169          GO TO 100
ISN 0170      106 CONTINUE
ISN 0171       37 IF (NTA-2)40,41,40
ISN 0172       41 WRITE (3) NNT,JW,(KAB(JJ),LT(JJ),LMA(JJ),JJ=1,JW)
ISN 0173       40 NCC=NCC+1
ISN 0174          GO TO 9
ISN 0175       15 WRITE (6,43)
ISN 0176       43 FORMAT (22H PROGRAMME INTERRUPTED)
ISN 0177          GO TO 22
ISN 0178       16 WRITE (6,45)
ISN 0179       45 FORMAT (20H PROGRAMME COMPLETED)
ISN 0180       22 WRITE (6,1) LNK,NCR,NCD,LFT,LFD,NOC,NPR,NTA,NHN,LHN,KZA
ISN 0181          WRITE (7,1) LNK,NCR,NCD,LFT,LFD,NOC,NPR,NTA,NHN,LHN,KZA
ISN 0182          REWIND 3
ISN 0183          STOP
ISN 0184          END

****** END OF COMPILATION ******
```

TABLE C.2

LISTING OF MINIMUM PATH PROGRAM

```
C      THIS PROGRAMME IDENTIFIES LINKS TRAVELLED VIA MINIMUM PATH TREE
C      FROM AN ORIGIN NODE TO A DESTINATION NODE IN NETWORK, LOADS LINKS,
C      AND CALCULATES TOTAL TRAVEL COST, TRAVEL DISTANCE AND TRAVEL TIME
C      FOR ANY GIVEN NETWORK AND TRIP INTERCHANGE PATTERN
C      PROGRAMME INPUT IS MAGNETIC TAPE AND OUTPUT MAY BE A LISTING AND/
C      OR PUNCHED CARDS
C      PROGRAMME IS WRITTEN SO THAT IT MAY BE INTERRUPTED
C      SEE PROGRAMME DESCRIPTION FOR DEFINITION OF VARIABLES USED
      DIMENSION LQ(3,4),LL(2000),LT(2000),LU(1000),LV(1000),LW(1000),
     1NO(2000),NTL(2000),LMA(1000),LVB(1000),LXD(600),LXT(600)
      REWIND 3
      READ (5,1) LNK,NOD,NPR,NPO,NOC,NOB,NDO,NTT,NTC,LHN,NHN,NPW,NPZ
    1 FORMAT (5I4,4I10,2I4,2I2)
      DO 2 J=1,LNK
      READ(5,80) N,ND,KS,KT,MW,MV,L
   80 FORMAT(2I5,I8,1X,I1,I7,1X,I2,I5)
      LT(L)=(10*KS)+KT
      LL(L)=(100*MW)+MV
      NO(L)=N
    2 CONTINUE
      DO 40 J=1,NOD
      READ (3) I,LC,(LQ(1,K),LQ(2,K),LQ(3,K),K=1,4)
   40 CONTINUE
      DO 5 I=1,LHN
      NTL(I)=0
      LMA(I)=0
      LVB(I)=0
    5 CONTINUE
      IF (NOB-1)3,4,4
    3 READ (3) NNT,JW,(NN,LW(NN),LU(NN),JJ=1,JW)
      ICTR=10
   12 READ (5,6) NTC,NTD,NTM
    6 FORMAT (2I4,I6)
      NPXO=0
      NPXT=0
      DO 7 I=1,1000
      LV(I)=0
    7 CONTINUE
      MM=NTD
      KK=0
      IF (NTD-NNT)8,9,10
    8 WRITE (6,11)
   11 FORMAT (40H NTC NTD    NTM TRIP CARD OUT OF SEQUENCE)
      WRITE (6,6) NTC,NTD,NTM
      GO TO 12
   10 IF (NTD-9997)38,13,14
   13 NOC=NOC+1
      GO TO 12
   38 IF (NTD-9995)8,8,3
   14 IF (NTD-9999)15,16,16
   15 WRITE (6,17)
   17 FORMAT(1H1,1X,'PROGRAM INTERRUPTED')
      GO TO 18
   16 WRITE (6,19)
   19 FORMAT (20H PROGRAMME COMPLETED)
      GO TO 18
    9 KK=KK+1
      MP=LU(MM)
```

TABLE C.2 (Continued)

```
ISN 0051              LV(KK)=LU(MM)
ISN 0052              LXD(KK)=LL(MP)
ISN 0053              LXT(KK)=LT(MP)
ISN 0054              NPXD=NPXD+LL(MP)
ISN 0055              NPXT=NPXT+LT(MP)
ISN 0056              NDD=NDD+(NTM*LL(MP))
ISN 0057              NTT=NTT+(NTM*LT(MP))
ISN 0058              NTL(MP)=NTL(MP)+NTM
ISN 0059              MM=NO(MP)
ISN 0060              IF (MM-NTC)9,20,9
ISN 0061           20 NTC=NTC+(NTM*LW(NTD))
ISN 0062              IF (NPR-2)22,21,22
ISN 0063           21 IF(ICTR.LT.5) GO TO 87
ISN 0065              WRITE(6,23)
ISN 0066           23 FORMAT(1H1,5X,'1964 EDMONTON TRANSIT NETWORK      TRIP PATH'//)
ISN 0067              WRITE(6,81)
ISN 0068           81 FORMAT(1X,'ORIGIN DEST. NO OF TRIP  TRIP    ',
                     13('----LINK----- ',2X)/)
ISN 0069              WRITE(6,24)
ISN 0070           24 FORMAT(1X,'CENT.  CENT. LINKS TIME LENGTH  ',
                     13('NO. TIME DIST    '),/)
ISN 0071              ICTR=0
ISN 0072           87 WRITE(6,25) NTO,NTD,KK,NPXT,NPXD
ISN 0073           25 FORMAT(//1X,I4,I7,I8,I5,I6)
ISN 0074              ICTR=ICTR+1
ISN 0075              WRITE(6,82)(LV(K),LXT(K),LXD(K),K=1,KK)
ISN 0076           82 FORMAT(33X,I3,2I5,3X,I3,2I5,3X,I3,2I5)
ISN 0077           22 IF (NPU-2)27,26,27
ISN 0078           26 WRITE(7,28)NTC,NTD,KK,NPXT,NPXD
ISN 0079           28 FORMAT(1X,I3,I4,3I8)
ISN 0080              WRITE(7,85)(LV(K),LXT(K),LXD(K),K=1,KK)
ISN 0081           85 FORMAT(15I5)
ISN 0082           27 NCB=NCB+1
ISN 0083              GO TO 12
ISN 0084            4 READ (5,29) KU
ISN 0085              READ (5,29) (J,NTL(J),JJ=1,KU)
ISN 0086           29 FORMAT (6(1X,I4,I7))
ISN 0087              IF (NOC-1)3,39,39
ISN 0088           39 DO 36 I=1,NOC
ISN 0089              READ (3) NNT,JW,(NN,LW(NN),LU(NN),JJ=1,JW)
ISN 0090           36 CONTINUE
ISN 0091              GO TO 3
ISN 0092           18 IF (NPZ-2)31,30,31
ISN 0093           30 WRITE(6,32)
ISN 0094           32 FORMAT(1H1,5X,'1964 EDMONTON TRANSIT NETWORK',
                     15X,'LOADED FOR TRIPS FROM ALL ORIGINS TO DESTINATIONS 1, 2, 4'//)
ISN 0095              WRITE(6,83)
ISN 0096           83 FORMAT(1X,8('---LINK--',4X))
ISN 0097              WRITE(6,84)
ISN 0098           84 FORMAT(1X,8('NO. TRIPS',4X,)/)
ISN 0099              KU=0
ISN 0100              DO 41 J=1,LHN
ISN 0101              IF (NTL(J)-1)41,42,42
ISN 0102           42 KU=KU+1
ISN 0103              LMA(KU)=J
ISN 0104              LVB(KU)=NTL(J)
ISN 0105           41 CONTINUE
ISN 0106              WRITE (6,33) (LMA(J),LVB(J),J=1,KU)
ISN 0107           33 FORMAT(8(1X,I3,I6,3X))
ISN 0108           31 IF (NPW-2)35,34,35
ISN 0109           34 WRITE (7,29) KU
ISN 0110              WRITE (7,29) (LMA(J),LVB(J),J=1,KU)
ISN 0111           35 WRITE(6,89)
ISN 0112           89 FORMAT(1H1)
ISN 0113              WRITE(6,1) LNK,NOD,NPR,NPU,NOC,NOB,NDD,NTT,NTC,LHN,NHN,NPW,NPZ
ISN 0114              WRITE (7,1) LNK,NOD,NPR,NPU,NOC,NOB,NDD,NTT,NTC,LHN,NHN,NPW,NPZ
ISN 0115              REWIND 3
ISN 0116              STOP
ISN 0117              END

****** END OF COMPILATION ******
```

APPENDIX D

MODE SPLIT PROGRAM

APPENDIX D

MODE SPLIT ANALYSIS

To test the differences between hand and mechanical coding assignment and analysis, and because a mode split analysis program would be a useful tool, a fairly major diversion from the original objective of the thesis in terms of time, was undertaken. TABLE D.1 is a listing of the mode split program and FIGURE D.1 is a flow chart of that program. The analysis follows Rhyason's method. TABLE D.2 is a listing of the Plot Subroutine of the Mode Split program, and FIGURE D.2 is a flow chart of that subroutine. TABLE D.3 is a listing of the Regression Analysis Subroutine of the Mode Split program, and FIGURE D.3 is a Flow Chart of that subroutine.

The following graphs illustrate the results of the Mode Split Program:

1. For destination 1, FIGURES D.4 to D.13 show the mode split curves and coefficient of correlation for each house value range. The first graph contains complete data, followed by a graph of data grouped to reduce scatter.

TABLE D.1

LISTING OF MODE SPLIT PROGRAM NO. 4

```
                C      PROGRAM CALCULATES MODE SPLIT, TRAVEL TIME RATIO, PLOTS
                C      GRAPHS MS VS TTR, CALCULATES ERROR OF ESTIMATE
ISN 0002               DIMENSION IOR(150),IZONE(150),IHV(150),TTT(150),ATT(150),
                      1BP(95),TRIP(95),C(16,100),M(16,100),R(16,100),TTR(95),
                      2AVMS(100),AVTR(100),PMS(95),STDEE(95),IHVG(95),MSHV(95),
                      3TRHV(95),MSHVA(100),TRHVA(100),MSO(95),
                      4WALKO(95),WALKD(95),TRANS(95),WAIT(95)
                C      ENTER NOR=NO. OF ORIGINS, NDST=NO. OF DESTINATIONS
ISN 0003               READ(5,5)NOR,NDST
ISN 0004             5 FORMAT(2I5)
                C      ENTER HOUSE VALUE TABLE. IOR=ORIGIN,IZONE=ZONE,IHV=HOUSE VALUE
ISN 0005               READ(5,10)(IOR(I),IZONE(I),IHV(I),I=1,NOR)
ISN 0006            10 FORMAT(2I5,I6)
ISN 0007               DO  210 JJ=1,NDST
ISN 0008               DO 16 I=1,NOR
                C      ENTER TOTAL TRANSIT TIME TABLE FOR NETWORK BEING TESTED
                C      IDST=DESTINATION,TTT=TOTAL TRANSIT TIME
ISN 0009               READ(5,15)IDST,IORR,TTT(I),TRANS(I),WAIT(I),WALKO(I),WALKD(I)
ISN 0010            15 FORMAT(2I5,F5.1,5X,4F5.1)
ISN 0011               IF(IORR.NE.IOR(I))GO TO 25
ISN 0013            16 CONTINUE
                C      ENTER GENERAL DATA. ATT=AUTO TOTAL TIME,BP=BRIDGE PENALTY,
                C      MSO=OBSERVED MODE SPLIT, TRIP=TRIPS FROM ORIGIN
                C      TRIPS COUNTS TOTAL TRIPS TO DESTINATION
ISN 0014               TMAX=0
ISN 0015               TRIPS=0.
ISN 0016               DO 35 I=1,NOR
ISN 0017               READ(5,20)IDDT,IOO,ATT(I),BP(I),MSO(I),TRIP(I)
ISN 0018            20 FORMAT(2I5,F5.1,F5.1,I5,F5.0)
ISN 0019               IF(IDDT.NE.IDST)GO TO 25
ISN 0021               IF(IOO.NE.IOR(I))GO TO 25
ISN 0023               TRIPS=TRIPS+TRIP(I)
ISN 0024               IHVG(I)=0
ISN 0025               PMS(I)=0.
ISN 0026               X=ATT(I)+BP(I)
ISN 0027               IF(X.LE.0.) GO TO 1003
ISN 0029               TTR(I)=TTT(I)/X
                C      TRAVEL TIME RATIO,TRANSIT DIV. BY AUTO. (1961 AUTO TIME)
                C      CORRECTED BY SO CALLED BRIDGE PENALTY.
ISN 0030               IF(TTR(I).GT.TMAX) TMAX=TTR(I)
ISN 0032            35 CONTINUE
                C      COUNTERS FOR GROUPING AND AVERAGING
ISN 0033               DO 37 L=1,16
ISN 0034               STDEE(L)=0.
ISN 0035               DO 36 IA=1,100
ISN 0036               C(L,IA)=0.
ISN 0037               M(L,IA)=0
ISN 0038               R(L,IA)=0.
ISN 0039            36 CONTINUE
ISN 0040            37 CONTINUE
ISN 0041               MMAX=(TMAX+1.)*10.
ISN 0042               DO 130 IA=10,MMAX,5
ISN 0043               DO 125 I=1,NOR
                C      GROUP ACCORDING TO HOUSE VALUE RANGE - SEE RHYASON, 1967
ISN 0044            41 GO TO (40,70,95),JJ
ISN 0045            40 KK=1
ISN 0046               KKK=5
ISN 0047               IF(IHV(I).GE.11000) GO TO 45
```

TABLE D.1 (Continued)

```
ISN 0049          L=1
ISN 0050          GO TO 120
ISN 0051       45 IF(IHV(I).GE.14000) GO TO 50
ISN 0053          L=2
ISN 0054          GO TO 120
ISN 0055       50 IF(IHV(I).GE.17000) GO TO 55
ISN 0057          L=3
ISN 0058          GO TO 120
ISN 0059       55 IF(IHV(I).GE.22000) GO TO 60
ISN 0061          L=4
ISN 0062          GO TO 120
ISN 0063       60 L=5
ISN 0064          GO TO 120
ISN 0065       70 KK=6
ISN 0066          KKK=9
ISN 0067          IF(IHV(I).GE.10000) GO TO 75
ISN 0069          L=6
ISN 0070          GO TO 120
ISN 0071       75 IF(IHV(I).GE.16000) GO TO 80
ISN 0073          L=7
ISN 0074          GO TO 120
ISN 0075       80 IF(IHV(I).GE.22000) GO TO 85
ISN 0077          L=8
ISN 0078          GO TO 120
ISN 0079       85 L=9
ISN 0080          GO TO 120
ISN 0081       95 KK=10
ISN 0082          KKK=13
ISN 0083          IF(IHV(I).GE.11000) GO TO 100
ISN 0085          L=10
ISN 0086          GO TO 120
ISN 0087      100 IF(IHV(I).GE.15000) GO TO 105
ISN 0089          L=11
ISN 0090          GO TO 120
ISN 0091      105 IF(IHV(I).GE.22000) GO TO 110
ISN 0093          L=12
ISN 0094          GO TO 120
ISN 0095      110 L=13
ISN 0096      120 CONTINUE
ISN 0097          IHVG(I)=L
               C  GROUP INTO .5 INCREMENTS OF TRAVEL TIME RATIO
ISN 0098          FIA=IA
ISN 0099          Z=FIA/10.
ISN 0100          IF(TTR(I).LT.Z) GO TO 125
ISN 0102          IF(TTR(I).GE.(Z+.5)) GO TO 125
ISN 0104       21 C(L,IA)=C(L,IA)+1.
ISN 0105          M(L,IA)=M(L,IA)+MSO(I)
ISN 0106          R(L,IA)=R(L,IA)+TTR(I)
ISN 0107      125 CONTINUE
ISN 0108      130 CONTINUE
ISN 0109      135 DO 160 L=KK,KKK
ISN 0110          Z=0.
ISN 0111          J=0
ISN 0112          MAX=IMAX*10.
ISN 0113          DO 145 IA=10,MAX,5
               C  FOR EACH HOUSE VALUE GROUP,ESTABLISH GROUPED VALUES OF MODE
               C  SPLIT AND TRAVEL TIME RATIO, FOR .5 INCREMENTS OF TTR
ISN 0114          FM=M(L,IA)
ISN 0115          IF(C(L,IA).EQ.0.) GO TO 145
```

TABLE D.1 (Continued)

```
ISN 0117          J=J+1
ISN 0118          AVMS(J)=FM/C(L,IA)
ISN 0119          AVTR(J)=R(L,IA)/C(L,IA)
ISN 0120      145 CONTINUE
ISN 0121          JMAX=J
ISN 0122          DO 144 J=1,JMAX
ISN 0123          DO 140 I=1,NOR
            C     FIND PREDICTED MODE SPLIT (BY ASSUMING THAT THE MS - TR
            C     RELATIONSHIP CAN BE APPROXIMATED BY A SERIES OF STRAIGHT
            C     LINES).PREDICTION IS BY INTERPOLATION BETWEEN AVE TTR
ISN 0124          IF(TTR(I).LT.AVTR(J).OR.TTR(I).GE.AVTR(J+1)) GO TO 140
ISN 0126          PMS(I)=AVMS(J)+(AVMS(J+1)-AVMS(J))*
                 1(AVTR(J)-TTR(I))/(AVTR(J)-AVTR(J+1))
            C     CALCULATE STANDARD ERROR OF ESTIMATE OF PREDICTED MODE SPLIT
ISN 0127          OMS=MSO(I)
ISN 0128          X=OMS-PMS(I)
ISN 0129          Y=TRIP(I)*X**2
ISN 0130          Z=Z+Y
ISN 0131          MSHV(I)=0
ISN 0132          TRHV(I)=0.
ISN 0133      140 CONTINUE
ISN 0134      144 CONTINUE
ISN 0135          STDEE(L)=(Z/TRIPS)**.5
ISN 0136          KNT=0
ISN 0137          KOUNT=0
ISN 0138          DO 150 I=1,NOR
ISN 0139          IF(IHVG(I).NE.L)GO TO 150
ISN 0141          KOUNT=KOUNT+1
ISN 0142          MSHV(KOUNT)=MSO(I)
ISN 0143          TRHV(KOUNT)=TTR(I)
ISN 0144      150 CONTINUE
ISN 0145          KTYPE=1
            C
ISN 0146          CALL PLOT (MSHV,TRHV,L,IDST,KTYPE,KOUNT)
            C
ISN 0147          DO 155 J=1,JMAX
ISN 0148          KNT=KNT+1
ISN 0149          MSHVA(KNT)=AVMS(J)
ISN 0150          TRHVA(KNT)=AVTR(J)
ISN 0151      155 CONTINUE
ISN 0152          KTYPE=2
            C
ISN 0153          CALL PLOT (MSHVA,TRHVA,L,IDST,KTYPE,KNT)
            C
ISN 0154      160 CONTINUE
ISN 0155          WRITE(6,165)
ISN 0156      165 FORMAT(1H1,10X,17HHOUSE VALUE TABLE)
ISN 0157          WRITE(6,170)
ISN 0158      170 FORMAT(///3(10X,6HORIGIN,5X,6HORIGIN,5X,5HHOUSE),/3(9X,
                 18HCENTROID,5X,4HZONE,6X,5HVALUE)//)
ISN 0159          M1=NOR/3+1
ISN 0160          IF((M1-1).EQ.NOR)  M1=NOR/3
ISN 0162          DO 176 I=1,M1
ISN 0163          II=I+M1
ISN 0164          III=I+(2*M1)
ISN 0165          IF(III.GE.(NOR+1)) GO TO 171
ISN 0167          IF(II.GE.(NOR+1)) GO TO 173
ISN 0169          WRITE(6,175)IOR(I),IZONE(I),IHV(I),
                 1IOR(II),IZONE(II),IHV(II),
```

TABLE D.1 (Continued)

```
                         2IOR(III),IZONE(III),IHV(III)
ISN 0170           175 FORMAT(3(10X,I5,6X,I5,6X,I5))
ISN 0171               GO TO 176
ISN 0172           171 WRITE(6,175)IOR(I),IZONE(I),IHV(I),
                         1IOR(II),IZONE(II),IHV(II)
ISN 0173               GO TO 176
ISN 0174           173 WRITE(6,175)IOR(I),IZONE(I),IHV(I)
ISN 0175           176 CONTINUE
ISN 0176               WRITE(6,180)IDST
ISN 0177           180 FORMAT(1H1,1X,36HTRAVEL TIME TABLE - DESTINATION ZONE,I5)
ISN 0178               WRITE(6,185)
ISN 0179           185 FORMAT(///3(5X,6HORIGIN,3X,7HTRANSIT,5X,4HAUTO),/3(4X,
                         18HCENTROID,3X,5HTOTAL,5X,5HTOTAL),/3(16X,4HTIME,6X,4HTIME)/)
ISN 0180               DO 191 I=1,M1
ISN 0181               II=I+M1
ISN 0182               III=I+(2*M1)
ISN 0183               IF(III.GE.(NOR+1)) GO TO 186
ISN 0185               IF(II.GE.(NOR+1)) GO TO 187
ISN 0187               WRITE(6,190)IOR(I),TTT(I),ATT(I),
                         1IOR(II),TTT(II),ATT(II),
                         2IOR(III),TTT(III),ATT(III)
ISN 0188           190 FORMAT(3(5X,I5,4X,F6.1,4X,F6.1))
ISN 0189               GO TO 191
ISN 0190           186 WRITE(6,190)IOR(I),TTT(I),ATT(I),
                         1IOR(II),TTT(II),ATT(II)
ISN 0191               GO TO 191
ISN 0192           187 WRITE(6,190)IOR(I),TTT(I),ATT(I)
ISN 0193           191 CONTINUE
ISN 0194               WRITE(6,195)IDST
ISN 0195           195 FORMAT(1H1,1X,16HMODE SPLIT TABLE,5X,'DESTINATION',I5)
ISN 0196               WRITE(6,200)
ISN 0197           200 FORMAT(/3(10X,6HORIGIN,2X,8HOBSERVED,2X,9HPREDICTED),/3(9X,
                         18HCENTROID,3X,4HMODE,7X,4HMODE,2X),/3(19X,5HSPLIT,6X,5HSPLIT,
                         22X)//)
ISN 0198               DO 215 I=1,M1
ISN 0199               II=I+M1
ISN 0200               III=I+(2*M1)
ISN 0201               IF(III.EQ.(NOR+1)) GO TO 201
ISN 0203               IF(II.EQ.(NOR+1)) GO TO 202
ISN 0205               WRITE(6,205)IOR(I),MSO(I),PMS(I),
                         1IOR(II),MSO(II),PMS(II),
                         2IOR(III),MSO(III),PMS(III)
ISN 0206           205 FORMAT(3(10X,I5,3X,I5,7X,F5.0,2X))
ISN 0207               GO TO 215
ISN 0208           201 WRITE(6,205)IOR(I),MSO(I),PMS(I),
                         1IOR(II),MSO(II),PMS(II)
ISN 0209               GO TO 215
ISN 0210           202 WRITE(6,205)IOR(I),MSO(I),PMS(I)
ISN 0211           215 CONTINUE
ISN 0212               WRITE(6,203)
ISN 0213           203 FORMAT(/////10X,'NOTE:  0.00 VALUES WERE NOT PREDICTED.',
                         1'  PROGRAM DOES NOT EXTRAPOLATE')
ISN 0214               WRITE(6,206)IDST
ISN 0215           206 FORMAT(1H1,10X,32HSTANDARD ERROR OF ESTIMATE TABLE, 10X,
                         110HDEST. ZONE,I5)
ISN 0216               WRITE(6,207)
ISN 0217           207 FORMAT(//20X,5HHOUSE,10X, 14HSTANDARD ERROR,/17X,
                         111HVALUE RANGE,9X,11HOF ESTIMATE/)
ISN 0218               DO 216 L=KK,KKK
```

TABLE D.1 (Continued)

```
           WRITE(6,208)L,STORE(L)
      208 FORMAT(20X,I3,16X,F6.2)
      216 CONTINUE
      210 CONTINUE
          GO TO 1000
     1003 WRITE(6,1002)IA,I,IOR(I),ATT(I),BP(I),X,TTT(I)
     1002 FORMAT(10X,'DIVIDE ERROR',3I6,4F10.2)
          GO TO 41
       25 WRITE(6,30)
       30 FORMAT(1H1,10X,15HDATA CARD ERROR)
     1000 STOP
          END

****** END OF COMPILATION ******
```

FIGURE D.1 FLOWCHART OF MODE SPLIT PROGRAM

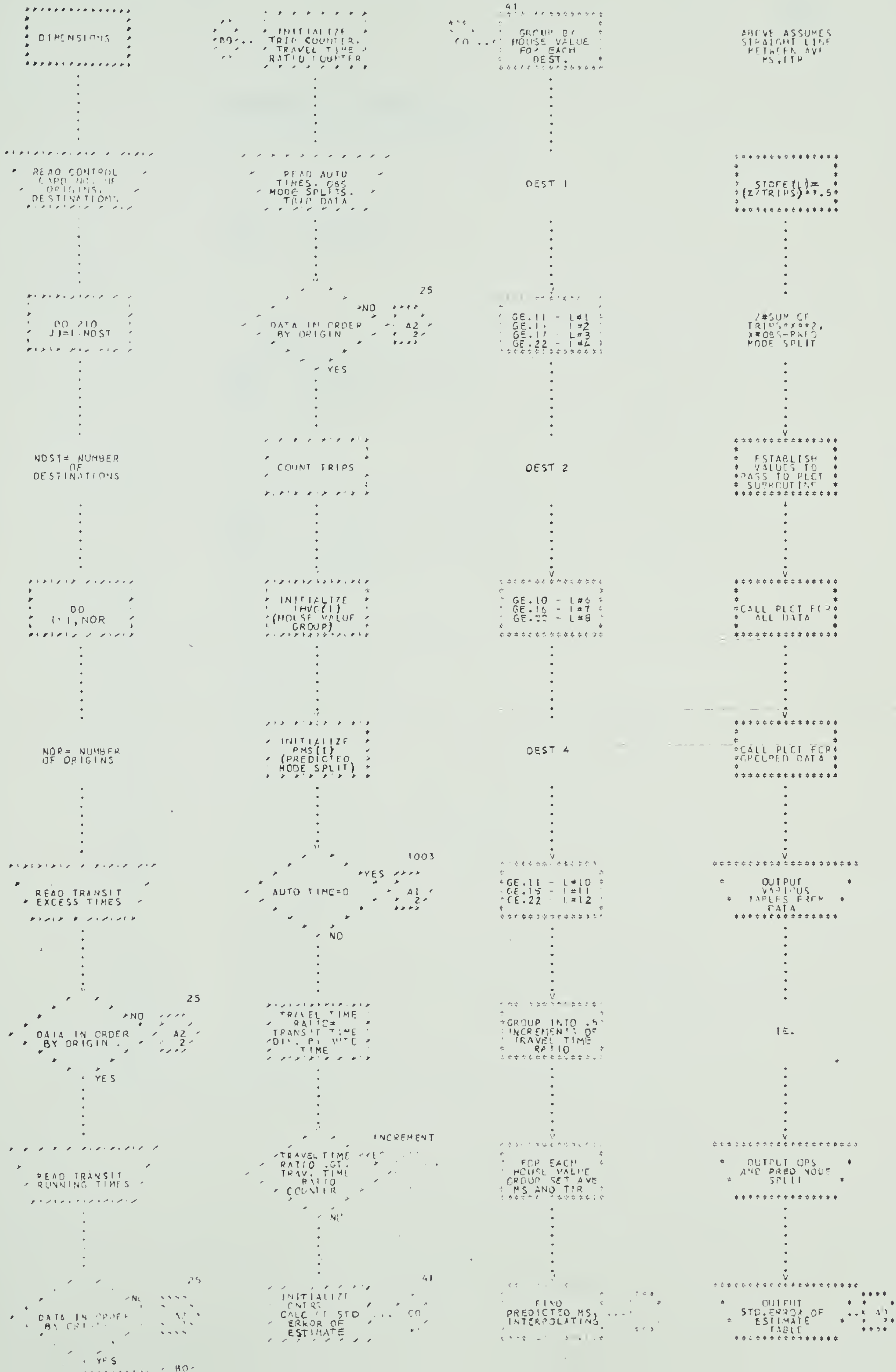


FIGURE D. 1 CONT.D

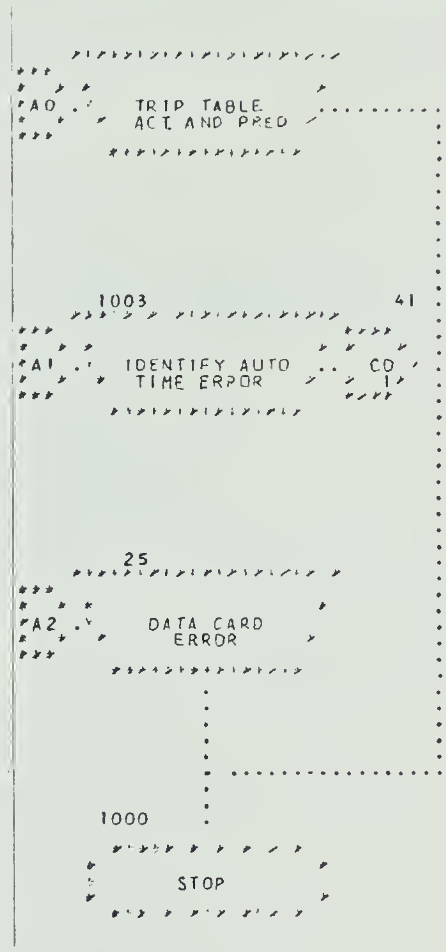


TABLE D.2

LISTING OF PLOT SUBROUTINE OF MODE SPLIT PROGRAM

```
ISN 0002          SUBROUTINE PLOT( MSC,TTR,L,IDST,KTYPE,NUM)
ISN 0003          DIMENSION MSC(95),TTR(95),LOTP(70,110),MISS(95),RS(95),
                 1ITLE(65),MS(200),XMSO(95)
ISN 0004          INTEGER VERT(200)
ISN 0005          DATA ITLE / 16*'    ', 'M   ', 'O   ', 'D   ', 'E   ', '    ',
                 1 'S   ', 'P   ', 'L   ', 'I   ', 'T   ', 2*'    ', '%   ', '    ',
                 2 'T   ', 'R   ', 'A   ', 'N   ', 'S   ', 'I   ', 'T   ',
                 3 28*'    ' /
ISN 0006          DATA LANK,ISK/4H    ,4H*   /, NEG,NEGNEG/4H -  ,4H--  /
ISN 0007          WRITE(6,7015)
ISN 0008     7015 FORMAT(1H1)
ISN 0009          WRITE(6,7000)
ISN 0010     7000 FORMAT(50X,'MODE SPLIT VS. TRAVEL TIME RATIO'/)
ISN 0011          WRITE(6,7001)IDST
ISN 0012     7001 FORMAT(56X,'DESTINATION ZONE ',I5/)
             C
             C    TEST THE VALUE OF L FOR THE HOUSE GROUP
             C
ISN 0013          IF(L.NE.1.AND.L.NE.10) GO TO 100
ISN 0015          WRITE(6,7002)
ISN 0016     7002 FORMAT(48X,'HOUSE VALUE GROUP - LESS THEN $11,000'/)
ISN 0017          GO TO 110
ISN 0018      100 IF(L.NE.2) GO TO 101
ISN 0020          WRITE(6,7003)
ISN 0021     7003 FORMAT(48X,'HOUSE VALUE GROUP - $11,000 TO $14,000'/)
ISN 0022          GO TO 110
ISN 0023      101 IF(L.NE.3) GO TO 102
ISN 0025          WRITE(6,7004)
ISN 0026     7004 FORMAT(48X,'HOUSE VALUE GROUP - $14,000 TO $17,000'/)
ISN 0027          GO TO 110
ISN 0028      102 IF(L.NE.4) GO TO 103
ISN 0030          WRITE(6,7005)
ISN 0031     7005 FORMAT(48X,'HOUSE VALUE GROUP - $17,000 TO $22,000'/)
ISN 0032          GO TO 110
ISN 0033      103 IF(L.NE.5.AND.L.NE.9.AND.L.NE.13) GO TO 104
ISN 0035          WRITE(6,7007)
ISN 0036     7007 FORMAT(48X,'HOUSE VALUE GROUP - GREATER THAN $25,000'/)
ISN 0037          GO TO 110
ISN 0038      104 IF(L.NE.6.) GO TO 105
ISN 0040          WRITE(6,7008)
ISN 0041     7008 FORMAT(48X,'HOUSE VALUE GROUP - LESS THAN $10,000'/)
ISN 0042          GO TO 110
ISN 0043      105 IF(L.NE.7) GO TO 106
ISN 0045          WRITE(6,7009)
ISN 0046     7009 FORMAT(48X,'HOUSE VALUE GROUP - $10,000 TO $16,000'/)
ISN 0047          GO TO 110
ISN 0048      106 IF(L.NE.8) GO TO 107
ISN 0050          WRITE(6,7010)
ISN 0051     7010 FORMAT(48X,'HOUSE VALUE GROUP - $16,000 TO $22,000'/)
ISN 0052          GO TO 110
ISN 0053      107 IF(L.NE.11) GO TO 108
ISN 0055          WRITE(6,7011)
ISN 0056     7011 FORMAT(48X,'HOUSE VALUE GROUP - $11,000 TO $15,000'/)
ISN 0057          GO TO 110
ISN 0058      108 IF(L.NE.12) GO TO 109
ISN 0060          WRITE(6,7006)
ISN 0061     7006 FORMAT(48X,'HOUSE VALUE GROUP - $15,000 TO $22,000'/)
ISN 0062          GO TO 110
```

TABLE D.2 (Continued)

```
ISN 0063         109 WRITE(6,7012)
ISN 0064        7012 FORMAT(48X,'HOUSE VALUE GROUP')
               C
               C     TEST FOR GROUPED OR UNGROUPED DATA
               C
ISN 0065         110 IF(KTYPE.NE.1) GO TO 111
ISN 0067             WRITE(6,7013)
ISN 0068        7013 FORMAT(59X,'UNGROUPED DATA')
ISN 0069             GO TO 112
ISN 0070         111 WRITE(6,7014)
ISN 0071        7014 FORMAT(59X,'GROUPED DATA')
               C
               C     THIS SECTION, TO STMT.15,INSERTS BLANKS(LANK) IN THE PLOTTING
               C     ARRAY LOTP.
ISN 0072         112 DO 15 I=1,65
ISN 0073             DO 16 II=1,101
ISN 0074             LOTP(I,II) = LANK
ISN 0075          16 CONTINUE
ISN 0076          15 CONTINUE
ISN 0077             LL=0
ISN 0078             LLL=0
ISN 0079             DO 20 I=1,NUM
               C     THE TWO IF'S CHECK LIMITS ON THE FUTURE X & Y COORDINATES
ISN 0080             IF( MSO(I).GT.80) GO TO 25
ISN 0082             IF( TTR(I).GT.5.0) GO TO 25
               C     N IS THE  Y-COORDINATE
ISN 0084             XMSO(I)=MSO(I)
ISN 0085             XN=(81.-XMSO(I))/1.687
ISN 0086             N = (XN +.5)
               C     NN IS THE X-COORDINATE
ISN 0087             NN =  (TTR(I)*20. + 1.)
ISN 0088             LOTP(N,NN) = ISK
ISN 0089             GO TO 20
               C     THIS RECORDS THOSE VALUES OUTSIDE THE RANGE OF THE GRAPH
ISN 0090          25 LL=LL+1
ISN 0091             LLL = LLL +1
ISN 0092             MISS(LL) = MSO(I)
ISN 0093             RS(LLL)  = TTR(I)
ISN 0094          20 CONTINUE
               C     SET UP THE VALUES FOR THE VERTICAL AXIS
               C     MS(I) REPRESENTS THE DIGITS ALONG THE AXIS
               C     VERT(I) REPRESENTS THE SCALE MARKINGS
               C
               C    BLANK THE MS(I) ARRAY AND SET THE VERT(I) ARRAY TO MINUS SIGNS IN
               C     THE SECOND POSITION
               C
ISN 0095             DO 50 I=1,48
ISN 0096             MS(I)=99
ISN 0097          50 VERT(I) = NEG
               C
               C     PLACE THE APPROPRIATE SCALE VALUE IN EVERY FOURTH POSITION OF
               C     MS(I) AND DOUBLE MINUS SIGNS IN EVERY FOURTH POSITION OF VERT(I)
               C
ISN 0098             KK = 80
ISN 0099             DO 55 I=1,48,3
ISN 0100             MS(I) = KK
ISN 0101             KK = KK-5
ISN 0102          55 VERT(I) = NEGNEG
               C     OUTPUT THE GRAPH
```

TABLE D.2 (Continued)

```
                C
  ISN 0103            DO 60 K=1,48
  ISN 0104            IF(MS(K).LT.99) GO TO 65
  ISN 0106            WRITE(6,8002)ITLE(K),VERT(K),(LOTP(K,L1),L1=1,101)
  ISN 0107       8000 FORMAT( 8X, A1, 3X, I2, A2, 101A1 )
  ISN 0108            GO TO 60
  ISN 0109         65 WRITE(6,8000)ITLE(K),MS(K),VERT(K),(LOTP(K,L2),L2=1,101)
  ISN 0110       8002 FORMAT(8X,A1,5X,A2,101A1)
  ISN 0111         60 CONTINUE
                C
                C     WRITE THE HORIZONTAL AXIS
                C
  ISN 0112            WRITE( 6, 8001 )
  ISN 0113       8001 FORMAT( 16X, 101('1') / 16X, 20( '1', 4X), '1' / 16X, '0', 8X,
                     1 '0.5', 7X, '1.0', 7X, '1.5', 7X, '2.0', 7X, '2.5', 7X, '3.0',
                     2 7X,'3.5',7X, '4.0', 7X, '5.0'/ 57X,  'TRAVEL TIME RATIO')
                C
                C     OUTPUT THOSE POINTS THAT FALL OUTSIDE THE GRAPH
                C
  ISN 0114            IF( LL .LE. 0  .OR. LLL .LE. 0 ) GO TO 70
                C
  ISN 0116            WRITE(6,8004)
  ISN 0117       8004 FORMAT( 1H1, 'THE FOLLOWING POINTS DO NOT LIE WITHIN THE BOUNDS OF
                     1 THE GRAPH.'// 5X, 'MODE SPLIT', 5X, 'TRAVEL-TIME RATIO.'// )
  ISN 0118            DO 75 J=1,LL
  ISN 0119            WRITE(6,8003) MISS(J),RS(J)
  ISN 0120       8003 FORMAT( 9X, I3, 15X, F4.1 )
  ISN 0121         75 CONTINUE
                C
  ISN 0122         70 RETURN
  ISN 0123            END

****** END OF COMPILATION ******
```

FIGURE D.2

FLOW CHART OF PLOT SUBROUTINE

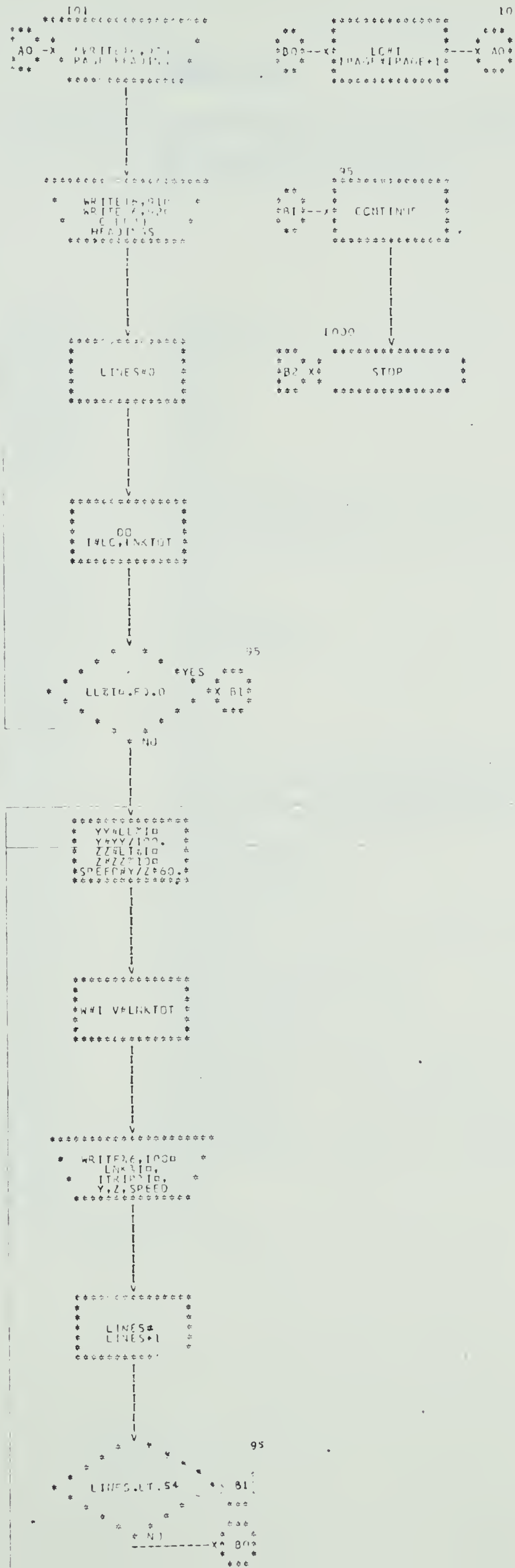


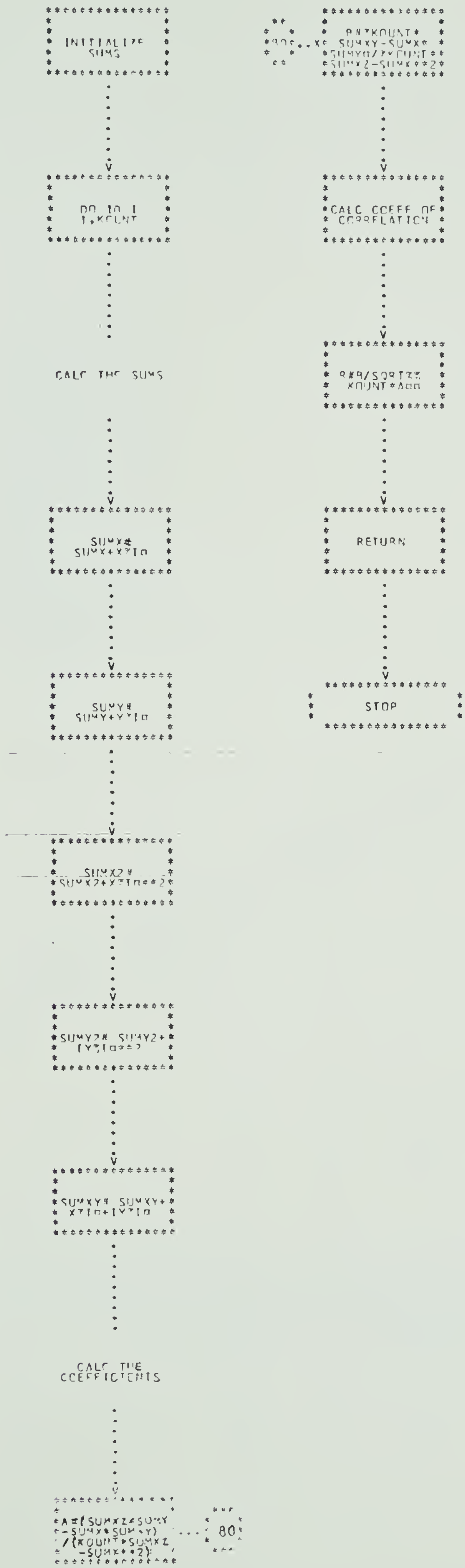
TABLE D.3

LISTING OF REGRESSION ANALYSIS SUBROUTINE OF MODE SPLIT PROGRAM

```
      IPAGE=0
    5 FORMAT(20A4)
      DIMENSION V(100),W(100),TITLE(20)
    2 READ(5,5) (TITLE(I),I=1,20)
    3 SUMX=0
      SUMY=0
      SUMX2=0
      SUMY2=0
      SUMXY=0
      N=0
    7 READ(5,10)IY,X
   10 FORMAT(6X,I10,F10.2)
C     CONTROL CARD AT END OF LAST DATA SET TO STOP PROGRAM
      IF(IY.GT.100) GO TO 120
C     CONTRIL CARD AT END OF EACH DATA SET TO RE-CYCLE
      IF(IY.LT.0) GO TO 30
      N=N+1
      Y=IY
      SUMX=SUMX+X
      SUMY=SUMY+Y
      SUMX2=SUMX2+X**2
      SUMY2=SUMY2+Y**2
      SUMXY=SUMXY+X*Y
      V(N)=Y
      W(N)=X
      GO TO 7
   30 CONTINUE
      FN=N
      A=(SUMX2*SUMY-SUMX*SUMXY)/(FN*SUMX2-SUMX**2)
      B#%FN*SUMXY-SUMX*SUMY</%FN*SUMX2-SUMX**2<
      C=(SUMY2*SUMX-SUMY*SUMXY)/(FN*SUMY2-SUMY**2)
      D=(FN*SUMXY-SUMY*SUMX)/(FN*SUMY2-SUMY**2)
      R#&FN*SUMXY-SUMX*SUMY</SQRT&%FN*SUMX2-SUMX**2<*%FN*SUMY2-SUMY**2<<
      WRITE&6,40<%TITLE&I<,I#1,20<
   40 FORMAT(1H1,20X,20A4)
      IPAGE#IPAGE&1
      WRITE(6,50)IPAGE
   50 FORMAT(80X,4HPAGE,I4)
      WRITE(6,60)
   60 FORMAT(/34X,'MODE SPLIT',3X,'TRAVEL TIME')
      WRITE(6,61)
   61 FORMAT(50X,'RATIO')
      WRITE(6,70)(V(I),W(I),I=1,N)
   70 FORMAT(32X,F10.0,2X,F10.2)
      IPAGE#IPAGE&1
      WRITE&6,40<%TITLF&I<,I#1,20<
      WRITE(6,50)IPAGF
      WRITE(6,80)
   80 FORMAT(/////38X,'REGRESSION LINE   Y  ON  X')
      WRITE(6,90)A,B
   90 FORMAT(/40X,3HY =,F10.4,2H +,F10.4,2H X)
      WRITE(6,100)
  100 FORMAT(/30X,'(Y= MODE SPLIT;  X= TRAVEL TIME RATIO')
      WRITE(6,110)R
  110 FORMAT(///38X,'COEFFICIENT OF CORRELATION =',F6.3)
      GO TO 2
  120 STOP
      END

****** END OF COMPILATION ******
```

FIGURE D.3 - FLOW CHART OF REGRESSION ANALYSIS SUBROUTINE



MODE SPLIT VS. TRAVEL TIME RATIO

DESTINATION ZONE 1

HOUSE VALUE GROUP - LESS THEN $11,000

UNGROUPED DATA

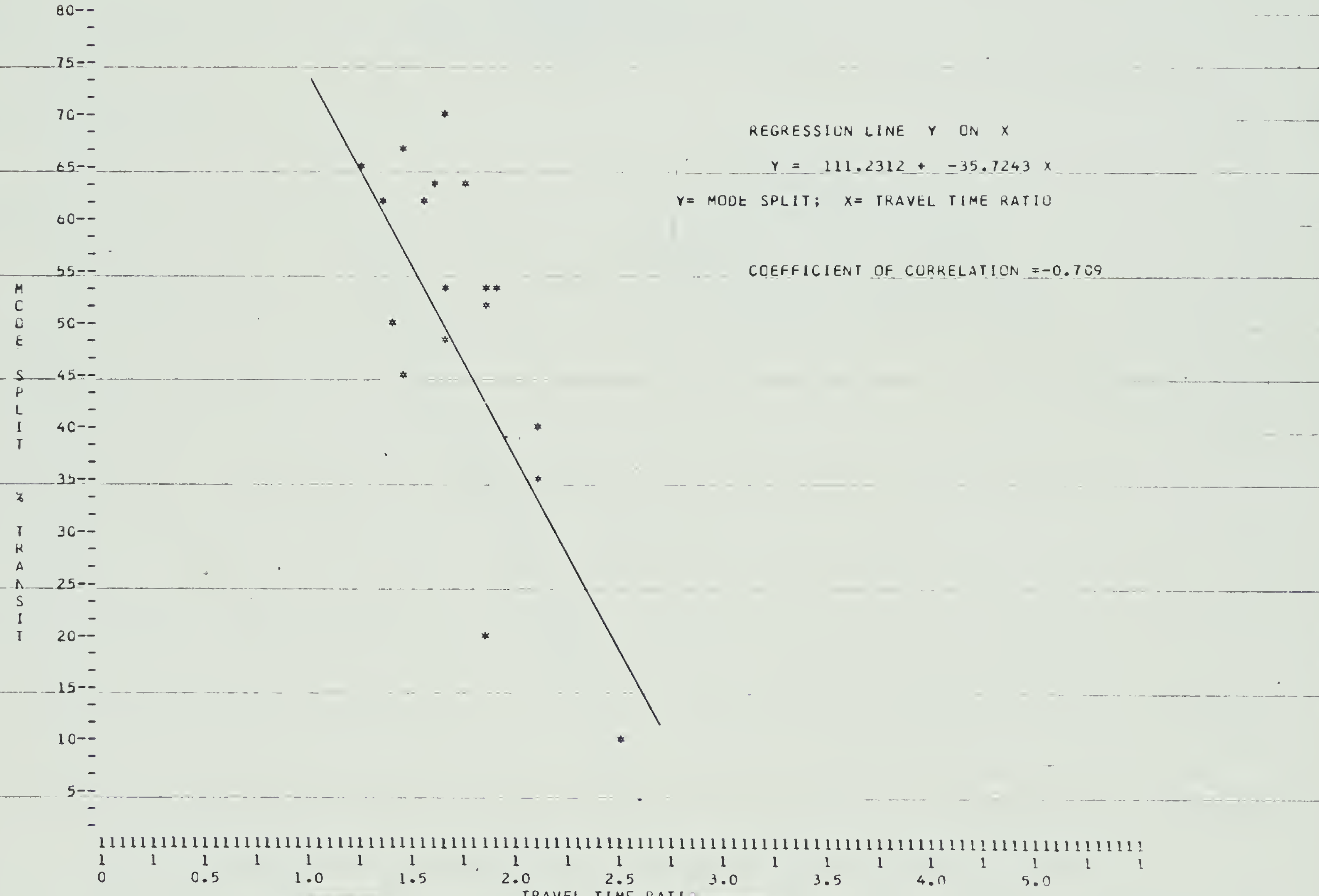


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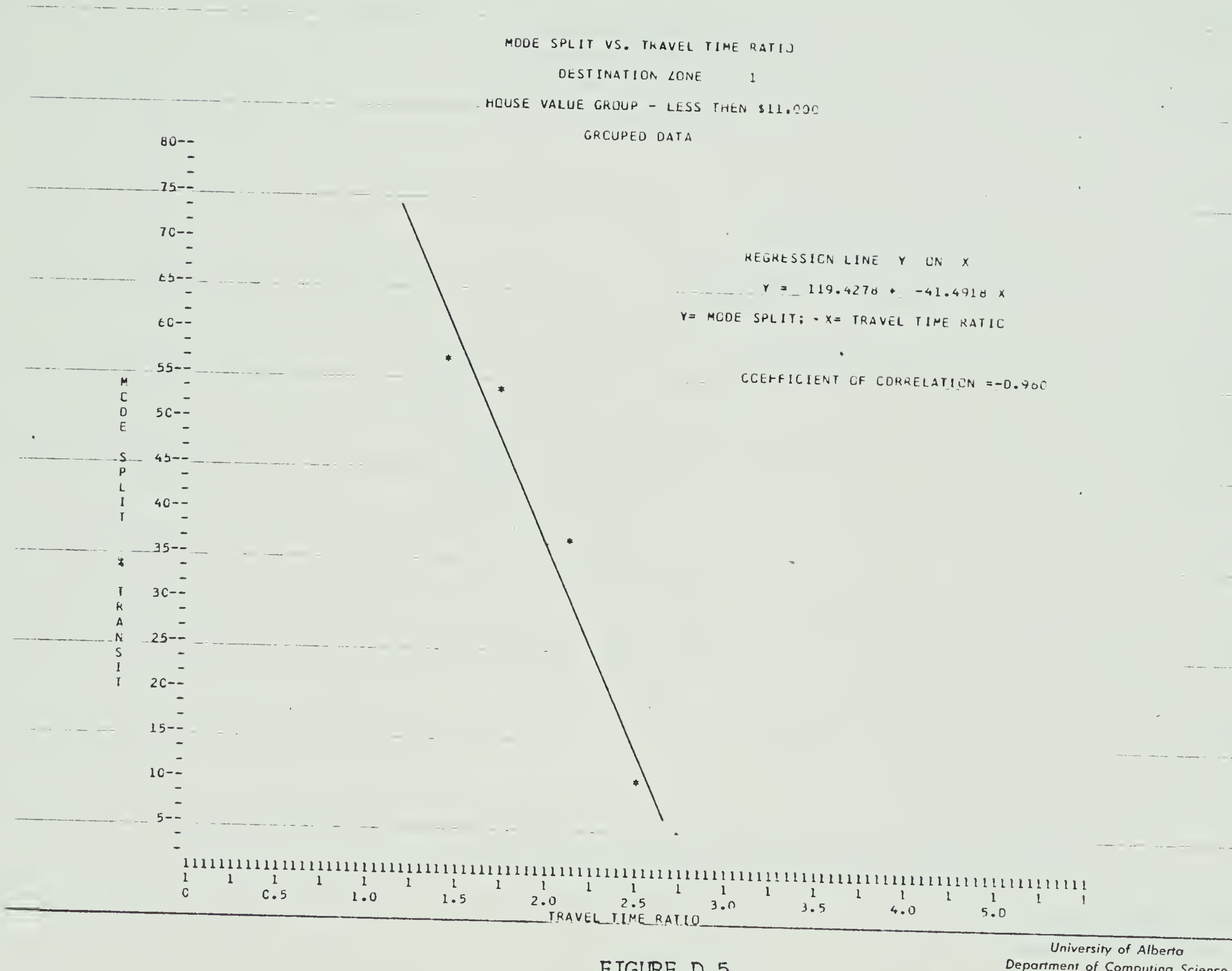
FIGURE D.4



MODE SPLIT VS. TRAVEL TIME RATIO
DESTINATION ZONE 1
HOUSE VALUE GROUP - LESS THEN $11,000
GROUPED DATA
REGRESSION LINE Y ON X
Y = 119.4278 + -41.4918 X
Y= MODE SPLIT; X= TRAVEL TIME RATIO
COEFFICIENT OF CORRELATION =-0.960
MODE SPLIT % TRANSIT
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
5.0
TRAVEL TIME RATIO
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FIGURE D.5

MODE SPLIT VS. TRAVEL TIME RATIO

DESTINATION ZONE 1

HOUSE VALUE GROUP - $11,000 TO $14,000

UNGROUPED DATA

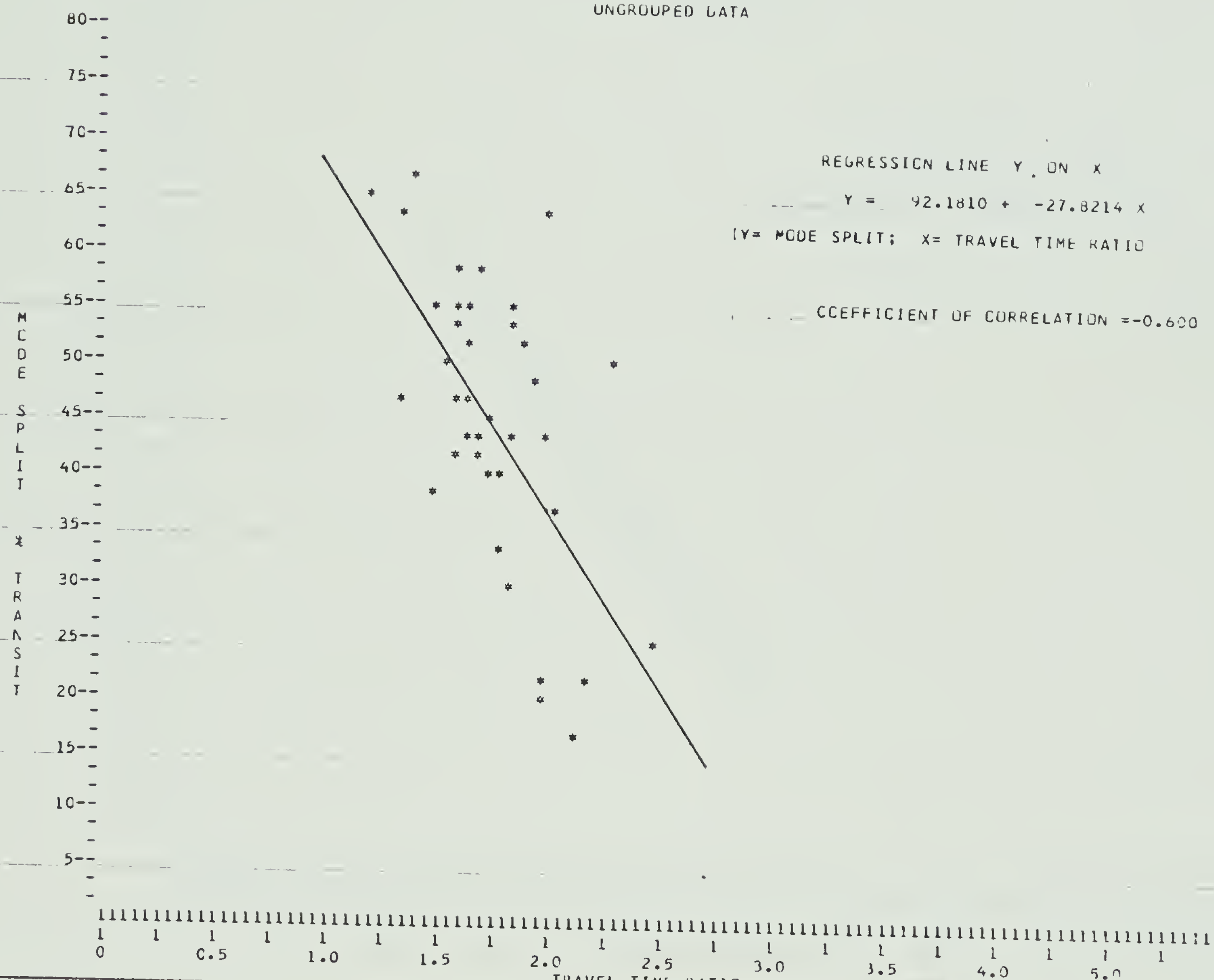

FIGURE D.6

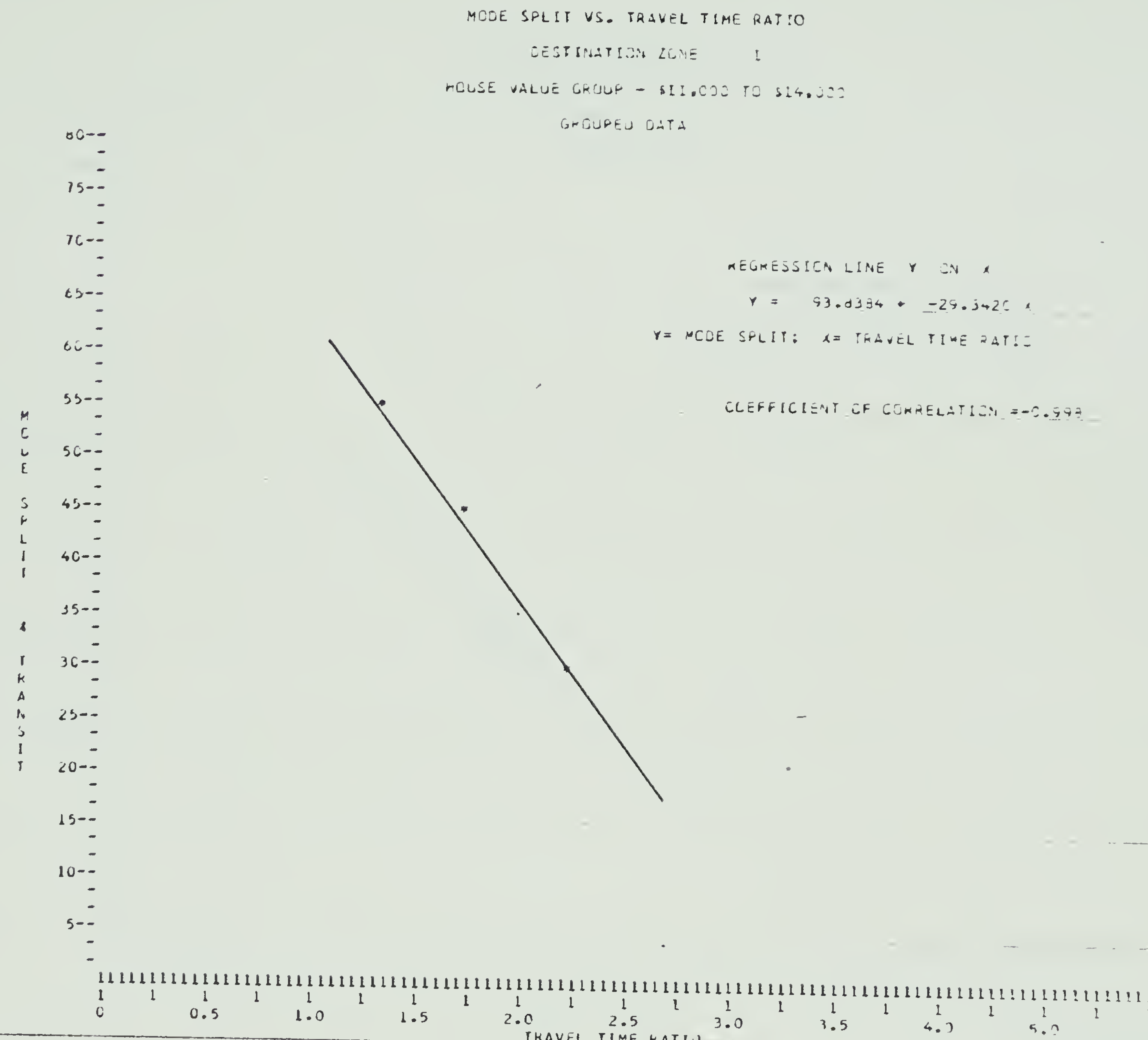

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FIGURE D.7

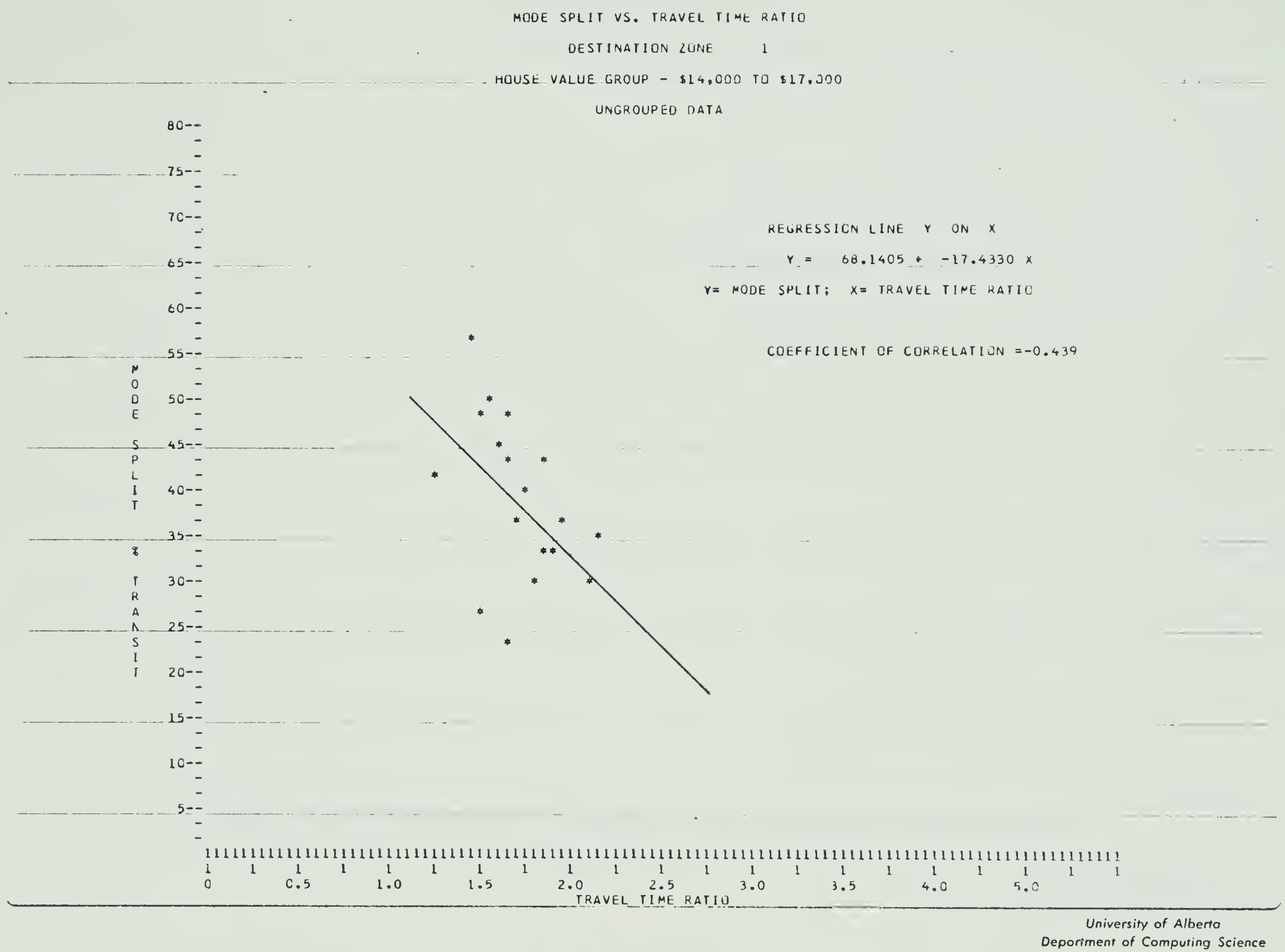
MODE SPLIT VS. TRAVEL TIME RATIO
DESTINATION ZONE 1
HOUSE VALUE GROUP - $14,000 TO $17,000
UNGROUPED DATA
REGRESSION LINE Y ON X
Y = 68.1405 + -17.4330 X
Y= MODE SPLIT; X= TRAVEL TIME RATIO
COEFFICIENT OF CORRELATION =-0.439
MODE SPLIT % TRANSIT
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
5.0
TRAVEL TIME RATIO
University of Alberta
Department of Computing Science

FIGURE D.8

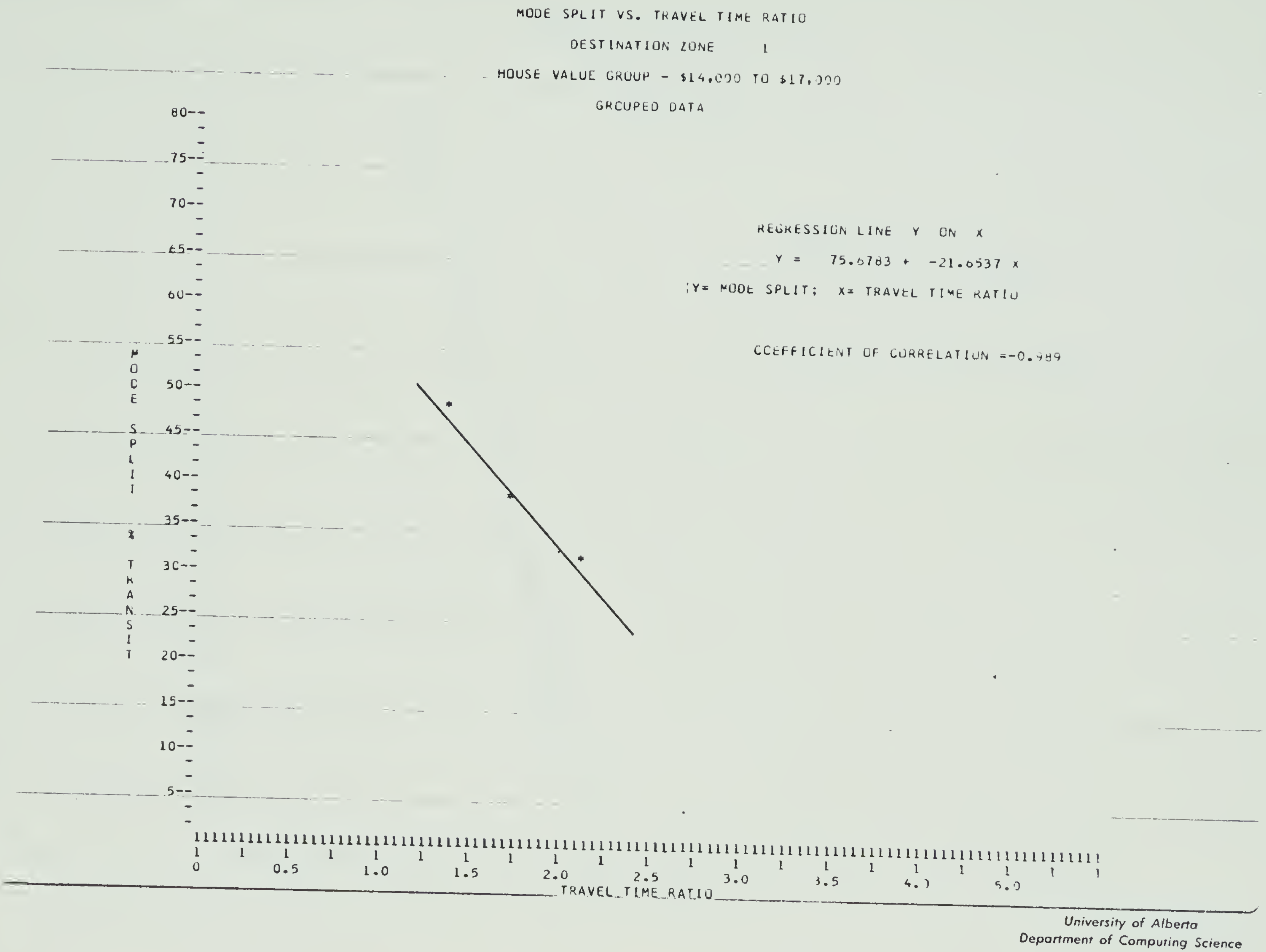
MODE SPLIT VS. TRAVEL TIME RATIO
DESTINATION ZONE 1
HOUSE VALUE GROUP - $14,000 TO $17,000
GROUPED DATA
REGRESSION LINE Y ON X
Y = 75.6783 + -21.6537 X
(Y= MODE SPLIT; X= TRAVEL TIME RATIO
COEFFICIENT OF CORRELATION =-0.989
MODE SPLIT % TRANSIT
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
5.0
TRAVEL TIME RATIO
University of Alberta
Department of Computing Science

FIGURE D.9

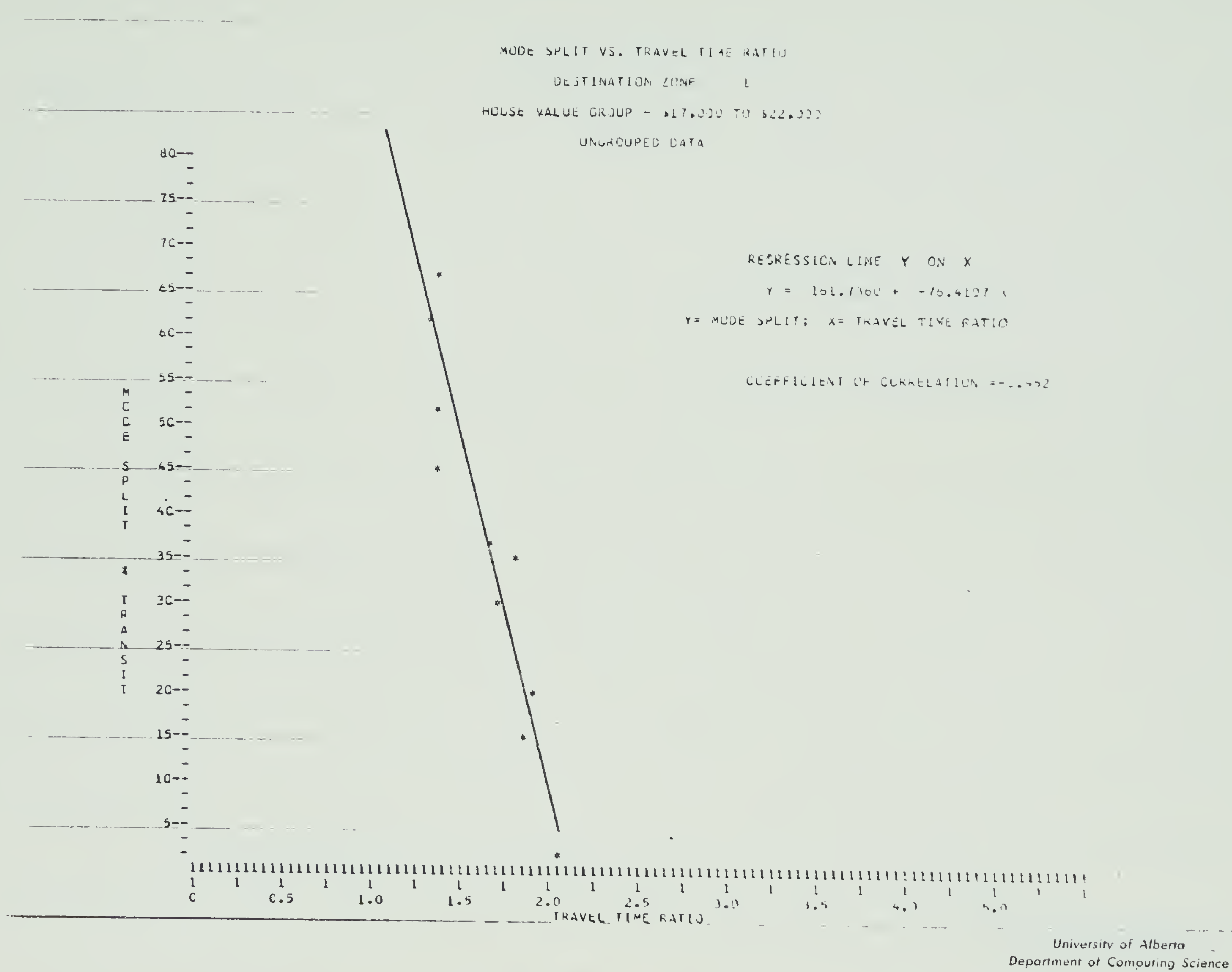
MODE SPLIT VS. TRAVEL TIME RATIO
DESTINATION ZONE 1
HOUSE VALUE GROUP - $17,000 TO $22,000
UNGROUPED DATA
REGRESSION LINE Y ON X
Y= MODE SPLIT; X= TRAVEL TIME RATIO
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
MODE SPLIT % TRANSIT
0
0.5
1.0
1.5
2.0
2.5
TRAVEL TIME RATIO
University of Alberta
Department of Computing Science

FIGURE D.10

MODE SPLIT VS. TRAVEL TIME RATIO

DESTINATION ZONE 1

HOUSE VALUE GROUP - $17,000 TO $22,000

GROUPED DATA

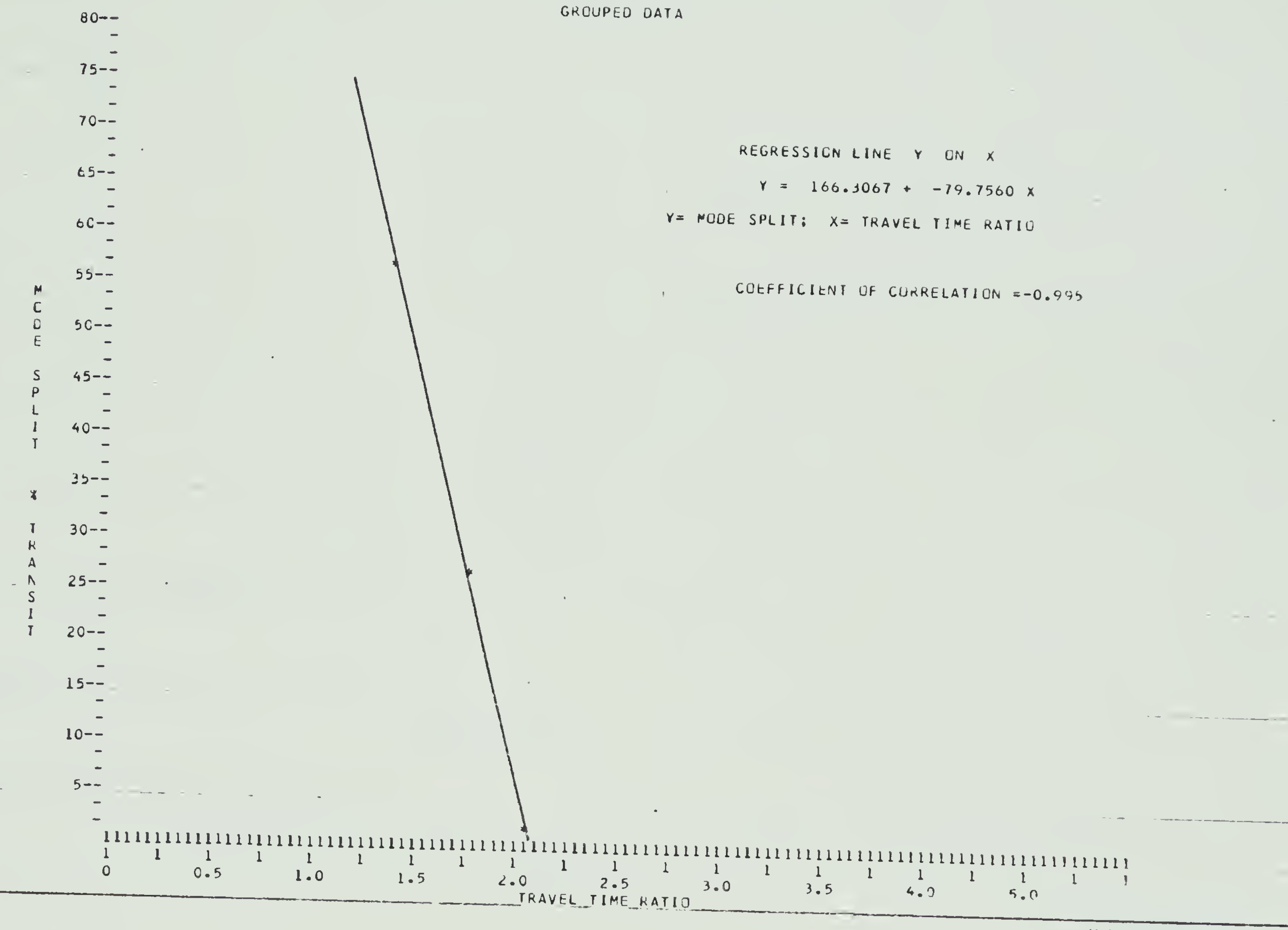

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FIGURE D.11

MODE SPLIT VS. TRAVEL TIME RATIO

DESTINATION ZONE 1

HOUSE VALUE GROUP - GREATER THAN $25,000

UNGROUPED DATA

REGRESSION LINE Y ON X

Y = 10.2169 + -0.6330 X

Y= MODE SPLIT; X= TRAVEL TIME RATIO

COEFFICIENT OF CORRELATION =-0.140

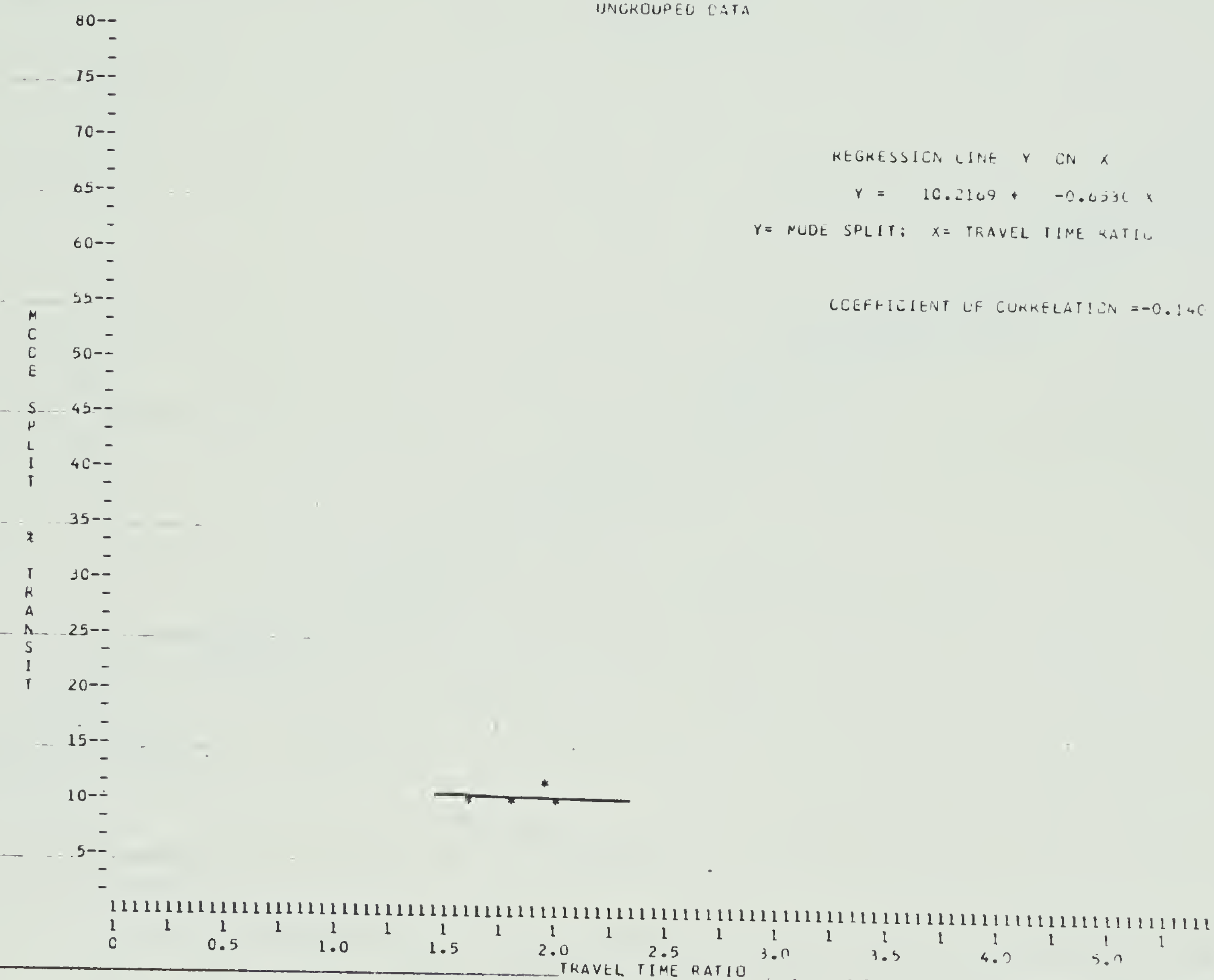

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FIGURE D.12

MODE SPLIT VS. TRAVEL TIME RATIO

DESTINATION ZONE 1

HOUSE VALUE GROUP - GREATER THAN $25,000

GROUPED DATA

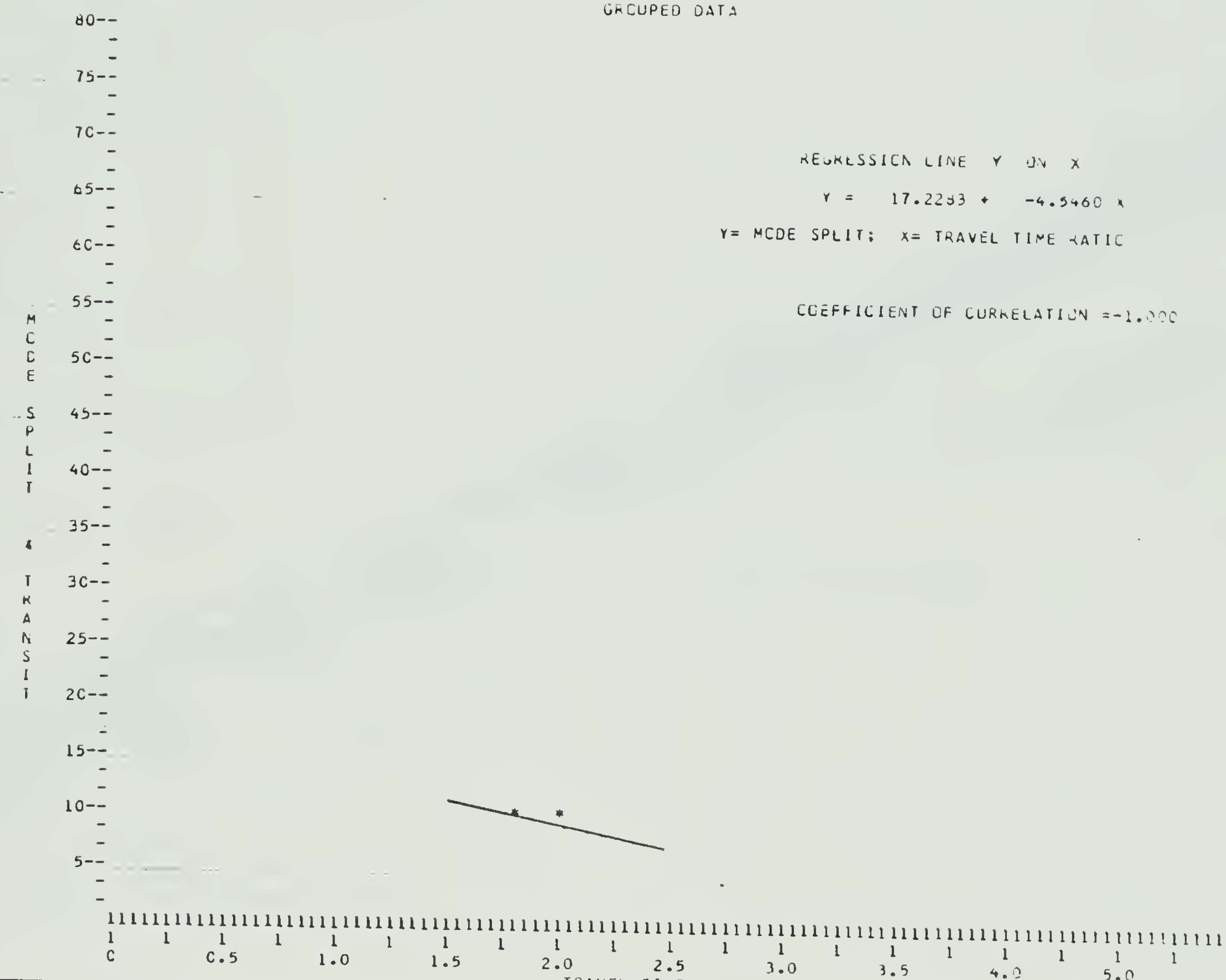


FIGURE D.13

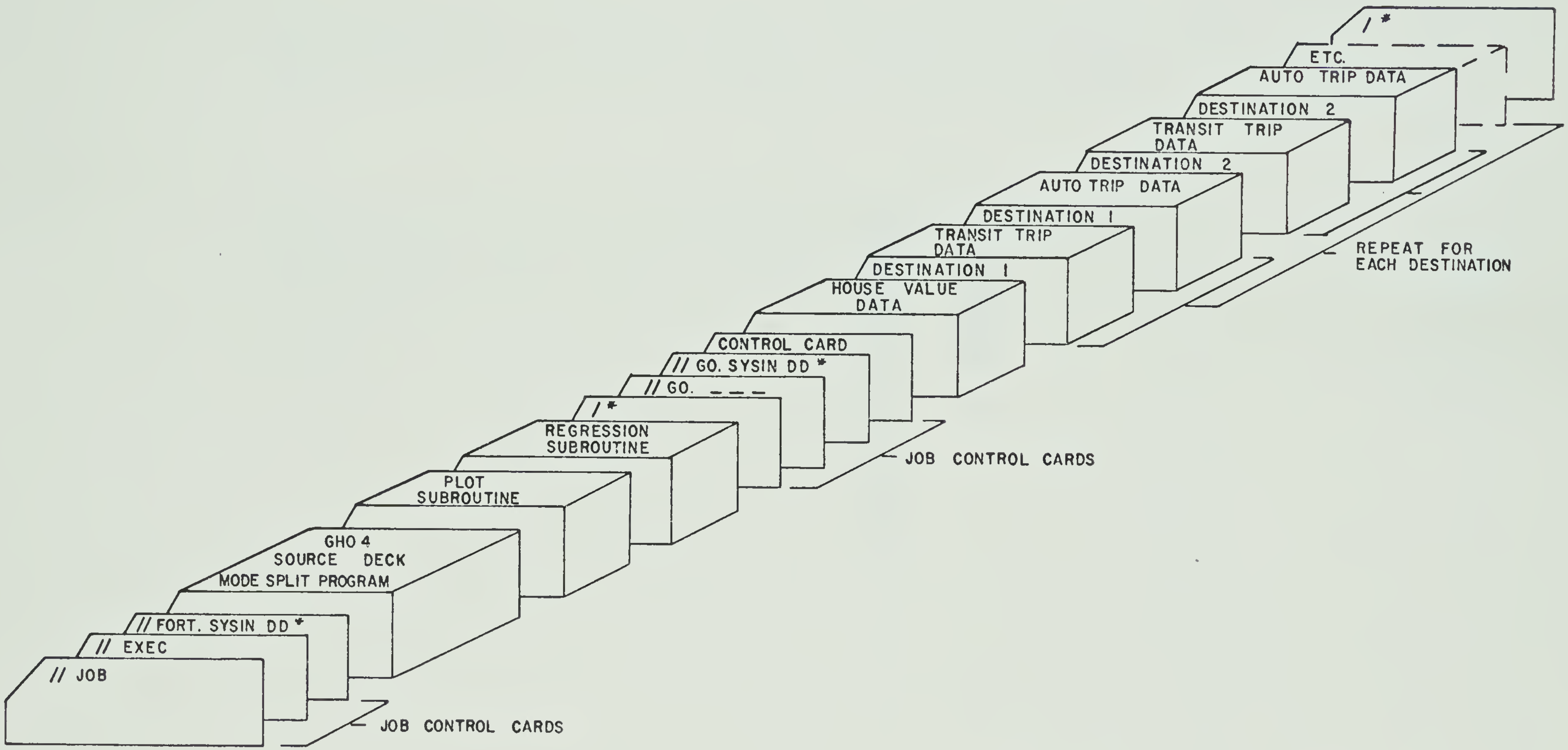


FIGURE D·14 DECK COMPOSITION —MODE SPLIT PROGRAM NO.4

APPENDIX E

REQUIRED SPEED PROGRAM

TABLE E.1

Listing of Required Speed Program No. 5

```
ISN 0002            DIMENSION TTR(13,10),LNK(999),LT(999),LL(999),TRUN(10),
                   1SPREQ(999,10),ITRIP(999),TIME(900),EXCESS(4,900),TATT(4,900),
                   2ESPEED(900),LINK(999),IHVG(4,300),LLNK(2000),
                   3LLL(2000),LLT(2000)
ISN 0003            READ(5,5)NOR,NDST,IRUN,IYEAR,ICTL,ITEST,LKHI
ISN 0004          5 FORMAT(10I5)
ISN 0005            DO 10 N=1,13
ISN 0006            READ(5,6) L,(TTR(L,M),M=2,6)
ISN 0007          6 FORMAT(I5,5F5.2)
ISN 0008         10 CONTINUE
ISN 0009            IPAGE=I
ISN 0010            DO 12 K=1,LKHI
ISN 0011            ESPEED=0.
ISN 0012            DO 11 M=2,6
ISN 0013            SPREQ(K,M)=0.
ISN 0014         11 CONTINUE
ISN 0015         12 CONTINUE
ISN 0016            LNKCTR=0
ISN 0017            NORTOT=NOR*NDST
ISN 0018            DO 13 I=1,NORTOT
ISN 0019            READ(5,15) IDST,IOR,IHVG(IDST,IOR),TTT,WALKO,WAIT,TRANS,WALKD,
                   1ATT,RP,TRIP,MSO,IHV
ISN 0020         15 FORMAT(3I5,8F5.1,2I5)
ISN 0021            TATT(IDST,IOR)=ATT+RP
ISN 0022            EXCESS(IDST,IOR)=WALKO+WAIT
ISN 0023         13 CONTINUE
ISN 0024         14 READ(5,3)IORTPE,IDSTPE,LINKS,ITIME,ILNTH
ISN 0025          3 FORMAT(2I4,3I8)
ISN 0026            IF(IORTPE.EQ.9999) GO TO 25
ISN 0028            TTIME=ITIME
ISN 0029            TLNTH=ILNTH
ISN 0030            READ(5,4)(LNK(K),LT(K),LL(K),K=1,LINKS)
ISN 0031          4 FORMAT(15I5)
ISN 0032            L=IHVG(IDSTPE,IORTPE)
ISN 0033            IF(L.EQ.0.OR.L.EQ.5.OR.L.EQ.9.OR.L.EQ.13) GO TO 25
ISN 0035            DO 16 M=2,6
ISN 0036            IF(TTR(L,M).LE.1) GO TO 25
ISN 0038            TRUN(M)=(TATT(IDSTPE,IORTPE)*TTR(L,M))-EXCESS(IDSTPE,IORTPE)
ISN 0039         16 CONTINUE
ISN 0040            DO 25 K=1,LINKS
ISN 0041            IF(LL(K).EQ.0.OR.LT(K).EQ.0) GO TO 25
ISN 0043            IF(TLNTH.LE.0.) GO TO 25
ISN 0045            KNL=LNK(K)
ISN 0046            X=LL(K)
ISN 0047            Y=LT(K)
ISN 0048            LNKCTR=LNKCTR+1
ISN 0049            LLNK(LNKCTR)=LNK(K)
ISN 0050            LLL(LNKCTR)=X
ISN 0051            LLT(LNKCTR)=Y
ISN 0052          8 DO 20 M=2,6
ISN 0053            TILNK=X/TLNTH*TRUN(M)
ISN 0054            REQSP=X/TILNK*.6
ISN 0055            IF(REQSP.LE.SPREQ(KNL,M)) GO TO 25
ISN 0057         18 SPREQ(KNL,M)=REQSP
ISN 0058            LINK(KNL)=KNL
ISN 0059            ESPEED(KNL)=X/Y*6.
ISN 0060         20 CONTINUE
ISN 0061         25 CONTINUE
```

TABLE E.1 (Continued)

```
ISN 0062          GO TO 14
ISN 0063       26 CONTINUE
ISN 0064          KCTR=1
ISN 0065       30 LINES=0
ISN 0066          WRITE(6,35)IRUN,IYEAR,IPAGE
ISN 0067       35 FORMAT(1H1,20X,'RUN NO.',I5,10X,I5,'   TRANSIT NETWORK',
                 1[7X,'PAGE',I5////)
ISN 0068          WRITE(6,45) IYEAR
ISN 0069       45 FORMAT(20X,'LINE',I6,2X,
                 1'SPEED REQ D TO ATTAIN VARIOUS MODE SPLITS')
ISN 0070          WRITE(6,50)
ISN 0071       50 FORMAT(21X,'NO.  SPEED      20%     30%     40%     50%     60%'//)
ISN 0072          DO 60 K=KCTR,LKHI
ISN 0073          M=2
ISN 0074          IF(SPREQ(K,M).EQ.0.) GO TO 60
ISN 0076          WRITE(6,55)LINK(K),ESPEED(K),(SPREQ(K,M),M=2,6)
ISN 0077       55 FORMAT(20X,I4,F6.1,1X,5F7.1)
ISN 0078          LINES=LINES+1
ISN 0079          IF(LINES.LE.51) GO TO 60
ISN 0081          KCTR=K+1
ISN 0082          IPAGE=IPAGE+1
ISN 0083          GO TO 30
ISN 0084       60 CONTINUE
ISN 0085          IF(ICTL.LT.1) GO TO 1000
ISN 0087          READ(5,5)LNKTOT
ISN 0088          DO 64 K=1,LNKTOT
ISN 0089          LT(K)=0
ISN 0090          LL(K)=0
ISN 0091       64 CONTINUE
ISN 0092          READ(5,70)(LNK(K),ITRIP(K),K=1,LNKTOT)
ISN 0093       70 FORMAT(6(I5,I7))
ISN 0094           DO 69 K=1,LNKTOT
ISN 0095          DO 68 IK=1,LNKCTR
ISN 0096          IF(LNK(K).NE.LLNK(IK)) GO TO 67
ISN 0098          LT(K)=LLT(IK)
ISN 0099          LL(K)=LLL(IK)
ISN 0100          GO TO 69
ISN 0101       67 LT(K)=0
ISN 0102          LL(K)=0
ISN 0103       68 CONTINUE
ISN 0104       69 CONTINUE
ISN 0105          L=LNKTOT-1
ISN 0106          DO 85 I=1,L
ISN 0107          JJ=LNKTOT-I
ISN 0108          DO 80 J=1,JJ
ISN 0109          IF(ITRIP(J).GT.ITRIP(J+1)) GO TO 75
ISN 0111          GO TO 80
ISN 0112       75 ITEM=ITRIP(J)
ISN 0113          METI=LNK(J)
ISN 0114          JHOLD=LL(J)
ISN 0115          KSTOR=LT(J)
ISN 0116          ITRIP(J)=ITRIP(J+1)
ISN 0117          LNK(J)=LNK(J+1)
ISN 0118          LL(J)=LL(J+1)
ISN 0119          LT(J)=LT(J+1)
ISN 0120          ITRIP(J+1)=ITEM
ISN 0121          LNK(J+1)=METI
ISN 0122          LL(J+1)=JHOLD
ISN 0123          LT(J+1)=KSTOR
```

TABLE E.1 (Continued)

```
ISN 0124          80 CONTINUE
ISN 0125          85 CONTINUE
ISN 0126             IPAGE=I
ISN 0127             LC=1
ISN 0128             X=ITEST
ISN 0129         101 WRITE(6,90) IPAGE
ISN 0130          90 FORMAT(1H1,/,1X,'LINKS IN ASCENDING ORDER OF LOAD',10X,'PAGE',I3)
ISN 0131             WRITE(6,91)
ISN 0132          91 FORMAT(/6X,'LINK      TRIPS      LINK           EXISTING ')
ISN 0133             WRITE(6,92)
ISN 0134          92 FORMAT(24X,'LENGTH      TIME      SPEED')
ISN 0135             LINES=0
ISN 0136             DO 95 I=LC,LNKTOT
ISN 0137             IF(LL(I).EQ.0) GO TO 95
ISN 0139             YY=LL(I)
ISN 0140             Y=YY/100.
ISN 0141             ZZ=LT(I)
ISN 0142             Z=ZZ/10.
ISN 0143             SPEED=Y/Z*60.
ISN 0144             W=I
ISN 0145             V=LNKTOT
ISN 0146             ADJSP=SPEED+W/V*X/100.
ISN 0147             TIME(I)=Y/ADJSP*60.
ISN 0148             WRITE(6,100)LNK(I),ITR(P(I),Y,Z,SPEED
ISN 0149         100 FORMAT(5X,I5,I10,4X,F5.2,2F10.1)
ISN 0150             LINES=LINES+1
ISN 0151             IF(LINES.LT.54) GO TO 95
ISN 0153             LC=I
ISN 0154             IPAGE=IPAGE+1
ISN 0155             GO TO 101
ISN 0156          95 CONTINUE
ISN 0157        1000 STOP
ISN 0158             END
```

FIGURE E.1

FLOW CHART OF REQUIRED SPEED PROGRAM NO. 5

E5

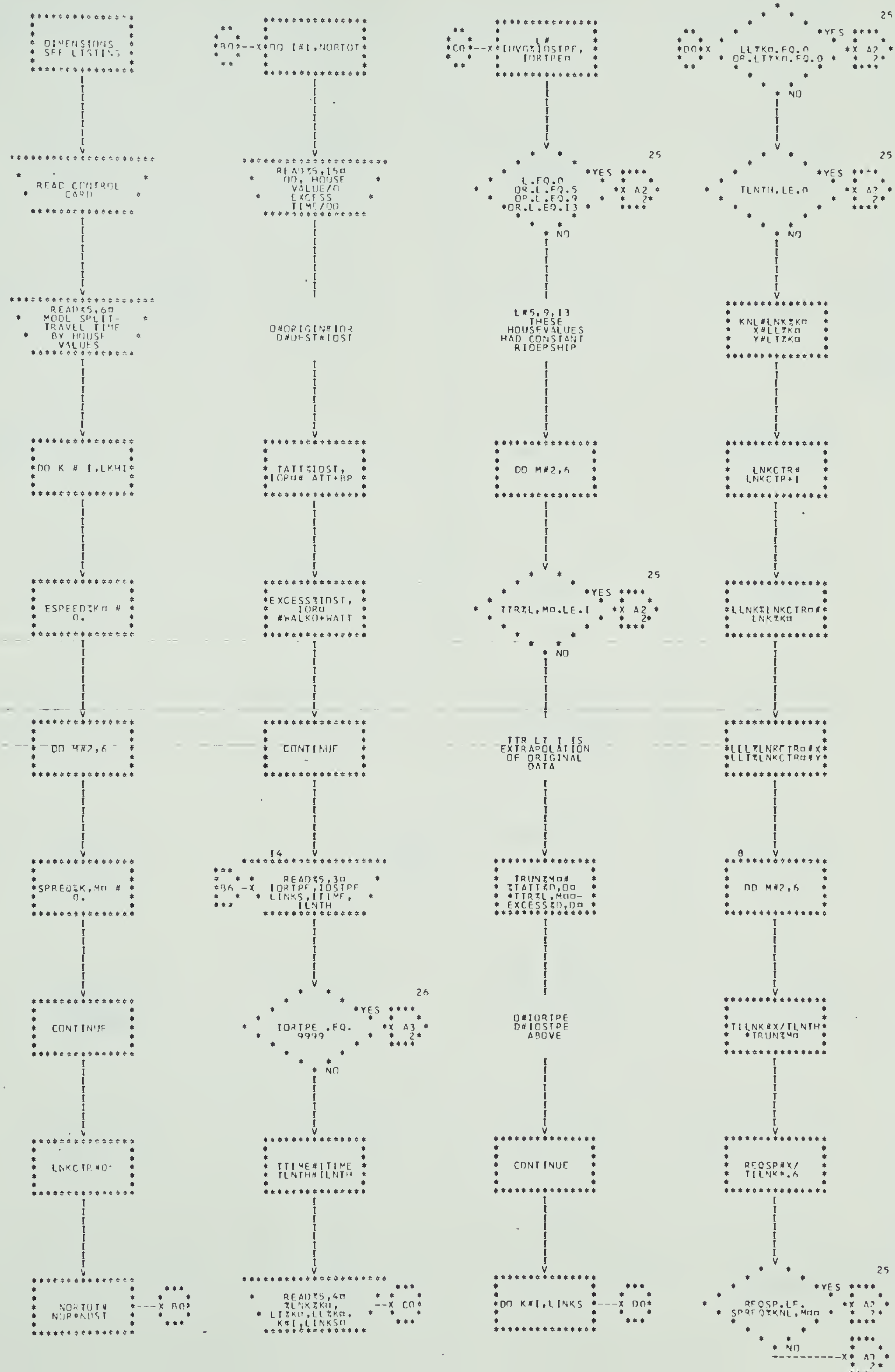
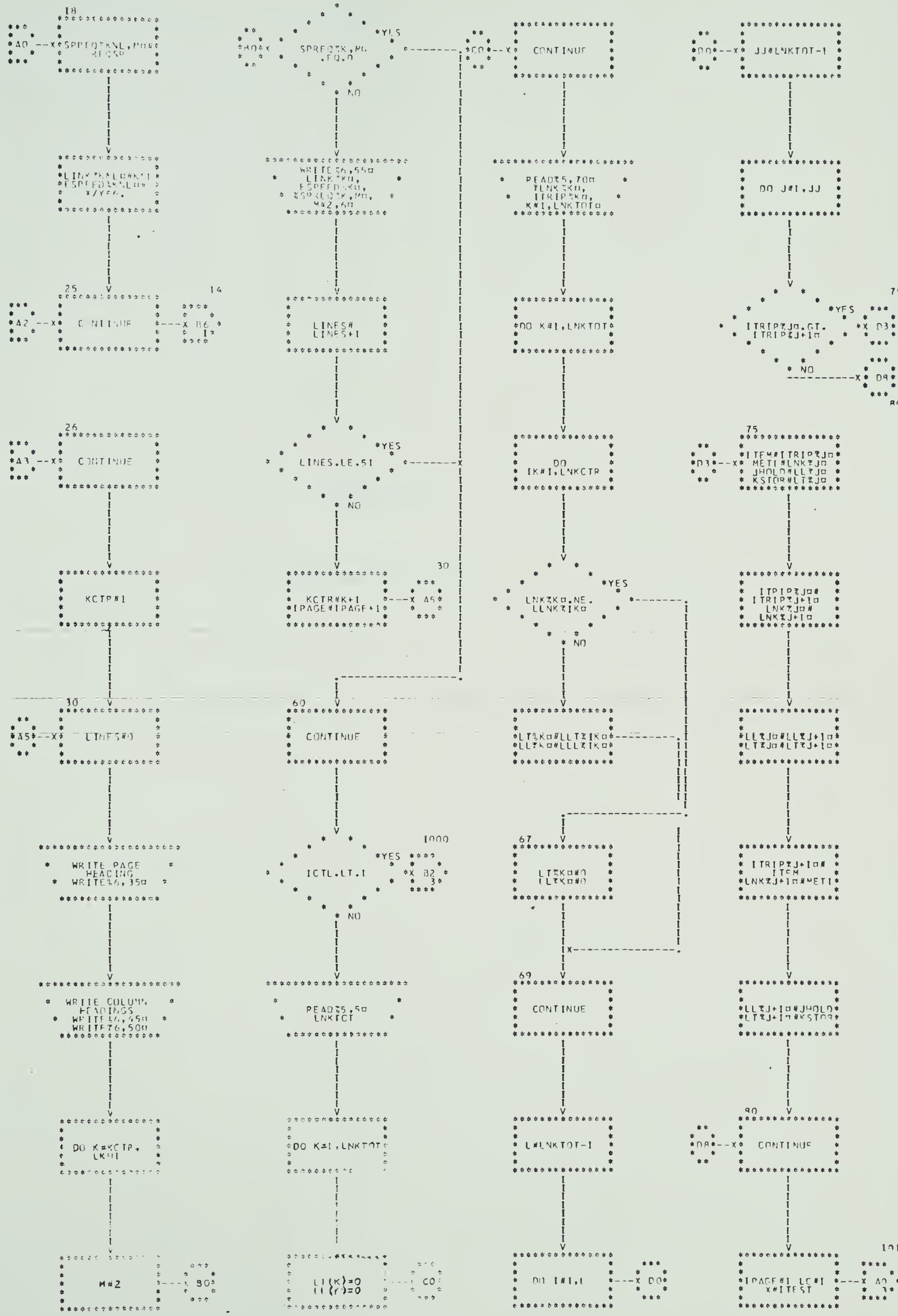


FIGURE E.1 (Continued)



APPENDIX F

TEST NETWORK MAPS

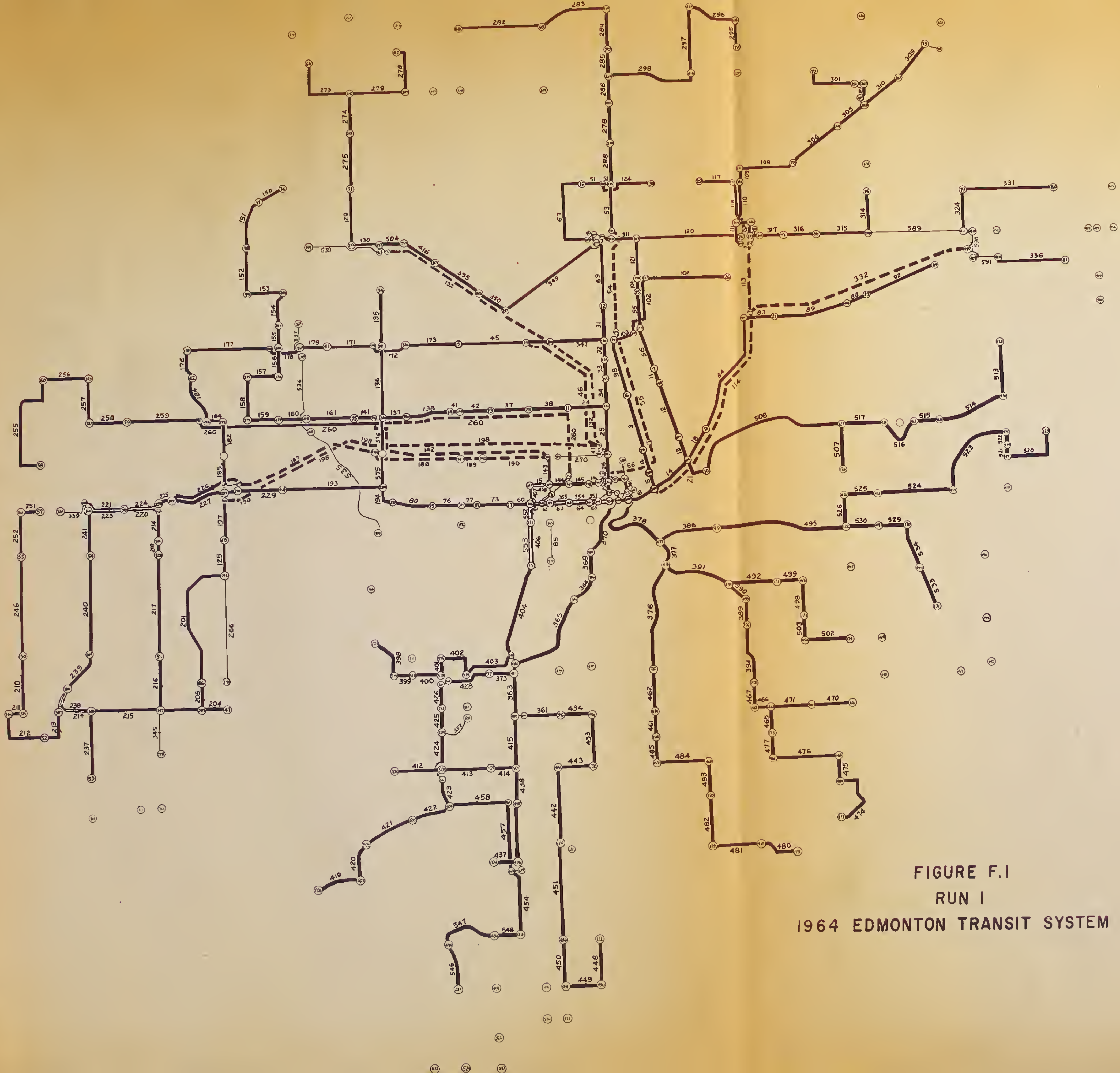


FIGURE F.1
RUN I
1964 EDMONTON TRANSIT SYSTEM

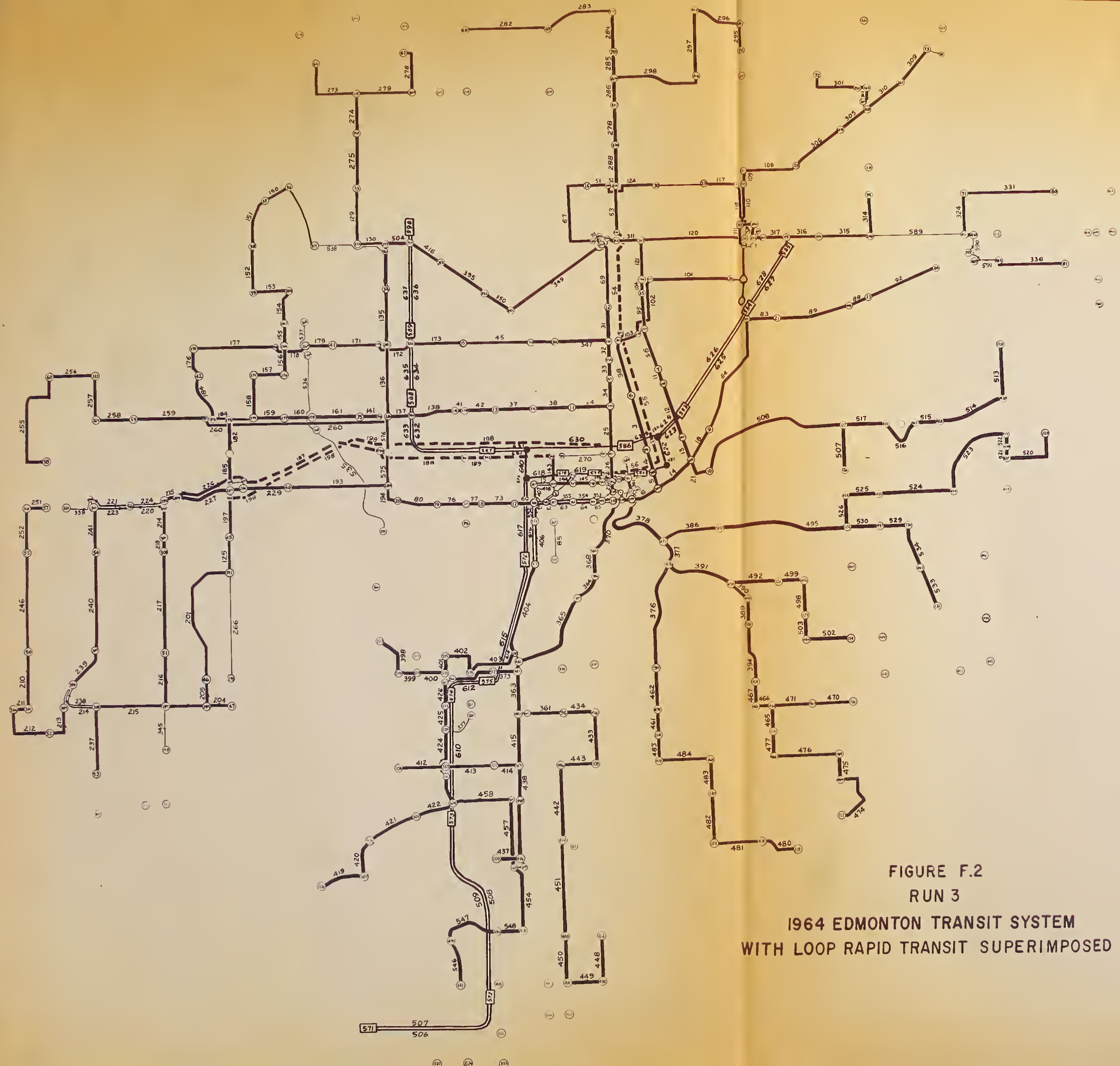


FIGURE F.2
RUN 3
1964 EDMONTON TRANSIT SYSTEM
WITH LOOP RAPID TRANSIT SUPERIMPOSED

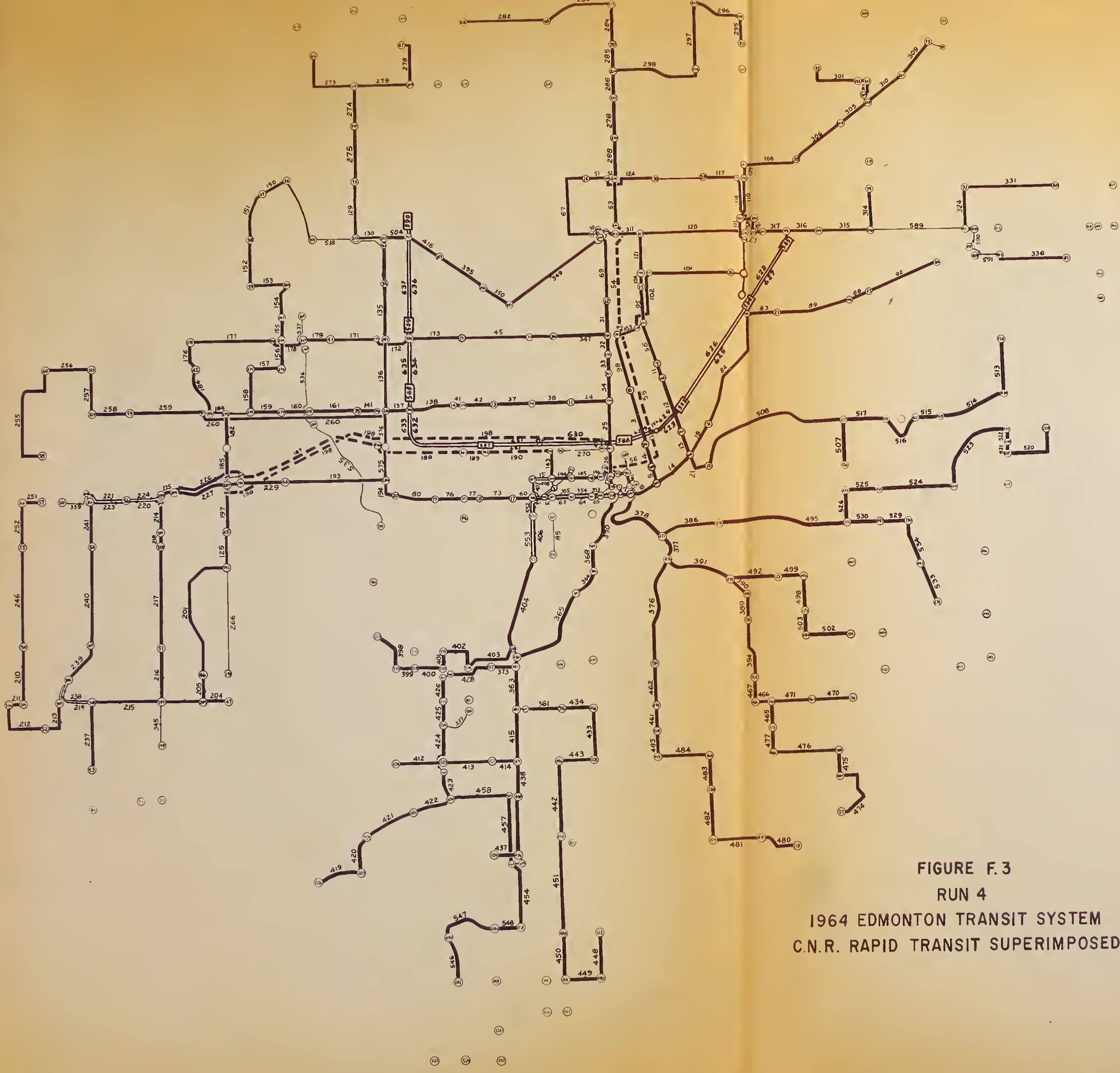


FIGURE F.3
RUN 4
1964 EDMONTON TRANSIT SYSTEM
C.N.R. RAPID TRANSIT SUPERIMPOSED